COLLIERY WORKING AND MANAGEMENT

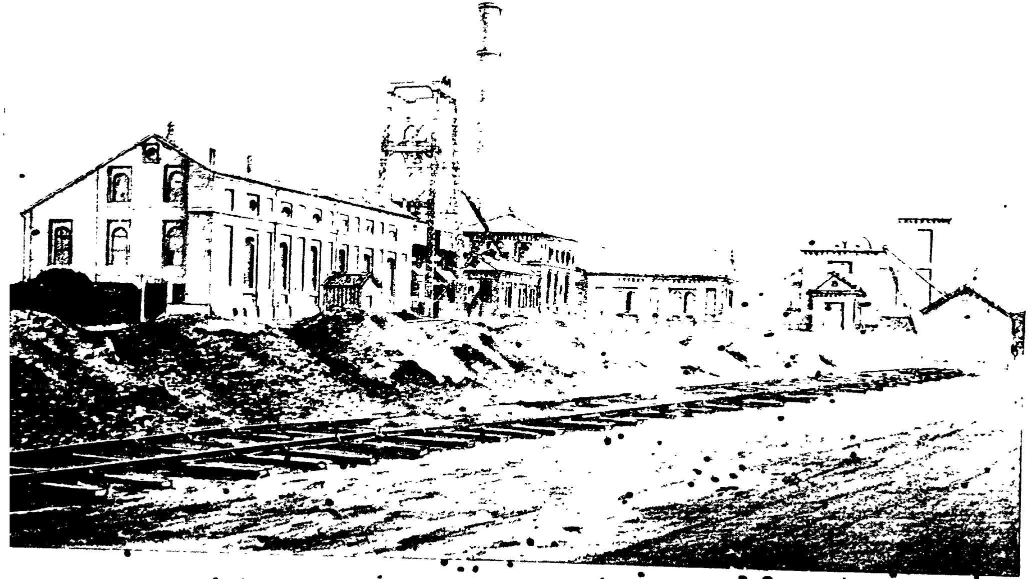


Fig. 1. New Hartley Colliery [illegible]

COLLIERY WORKING
AND
MANAGEMENT

COMPRISING

THE DUTIES OF A COLLIERY MANAGER
THE SUPERINTENDENCE & ARRANGEMENT OF LABOUR & WAGES
AND
THE DIFFERENT SYSTEMS OF WORKING COAL SEAMS

BY

H. F. BULMAN, F.G.S.
CERTIFICATED COLLIERY MANAGER, MEMBER OF THE INSTITUTION OF MINING ENGINEERS
ASSOCIATE-MEMBER OF THE INSTITUTION OF CIVIL ENGINEERS

AND

R. A. S. REDMAYNE, M.Sc., F.G.S.
CERTIFICATED COLLIERY MANAGER, MEMBER OF THE INSTITUTION OF MINING ENGINEERS
PROFESSOR OF MINING IN THE UNIVERSITY OF BIRMINGHAM

With Underground Photographs and Numerous other Illustration

SECOND EDITION, REVISED AND ENLARGED

LONDON
CROSBY LOCKWOOD AND SON
7 STATIONERS' HALL COURT, LUDGATE HILL
1906

PREFACE.

A LARGE modern colliery, with its extensive and carefully elaborated equipment—including its various appliances for getting the coal and bringing it to the surface, for transmitting power through long distances underground, for causing great volumes of air to flow through miles of confined passages, for draining wide areas of underground workings and raising the water to the surface, for sorting the coal into various sizes and separating from it the intermingled stone and dirt—offers (as has been well said) "one of the most remarkable specimens of human activity, and its triumph over matter." The successful working of a colliery implies the getting of the largest possible proportion of the workable coal in the best condition, at the lowest possible cost, and with the greatest safety and comfort to those employed. In order to attain this ideal, the method of working the coal should receive the fullest consideration, whilst the efficient organisation of the colliery—that is, the proper arrangement and supervision of the labour to be employed—is likewise a matter of the greatest moment.

These are truths which will at once be admitted by practical men; yet the matters referred to have received but scant treatment in the numerous works on Coal-mining which have been published during the last few years. Practical and useful as many of these are—dealing, most of them, with the engineering rather than with the working of collieries; or describing the machinery and appliances required at collieries; and in most cases being designed for the Mining Student rather than the Mine Manager—they have said little or nothing about labour, wages, cost of working, the daily routine of a colliery in work, or the actual duties of the Colliery Manager; and where they have touched upon systems of getting the coal, they have done so in brief outline rather than in working detail. In the present work the endeavour of the authors has been to deal with the side of the subject which has thus been neglected in the literature of Coal-mining.

The getting of the coal is the useful work to be done, to effect which is the object of all the organisation, both of men and of machinery, which has to be devised in and about a colliery; and the efficiency of the colliery may be expressed by the ratio which this result bears to the work expended. The work expended varies much at different collieries according to their natural conditions, but the less the work required to be performed for the purposes of drainage, haulage, lighting and ventilation, in order to raise a given quantity of coal, the higher is the value of the colliery. Its geographical position in relation to ports of shipment and main railways, or in other words the distance which the coal has to be conveyed to its chief markets, has necessarily a very important bearing on the prosperity of a colliery.

The uninitiated may think that one coal seam is very much like another, and even that all seams may be worked to advantage on one plan. As a matter of fact, there is endless variety, both in the natural conditions of the seams, and in the means best adapted for working them. Coal seams are found varying in thickness from a few inches to thirty feet or more, and lying at all angles between a horizontal and a vertical line; differing much in hardness and texture; often containing bands of stone or clay interstratified with them; some of them liberating during the process of working large volumes of explosive gases, while others are entirely free from gas; some dry and dusty; others abounding in water. Sometimes the "roof" will stand without any support over considerable areas of excavation, and sometimes it will break down the strongest supports. Similarly the "floor" is sometimes hard and firm, and sometimes it heaves up readily when the coal has been removed. All seams have been subject, more or less, to geological dislocations—"faults," "dykes," "nip-outs," and "balks"—and these, being in many instances previously indeterminable quantities, are apt to disturb the best-laid plans of developmen and working. Again, the distance between workable seams and in many cases the probable effect on buildings on th surface, are points which must be taken into consideration while the size and shape of the coal properties to be worked, and the royalty and wayleave rents to be paid, may hav an important bearing on the direction in which the main roads should be driven.

In dealing with Colliery Working in contradistinction to Mine Engineering, the authors have tried to show what progress has been made during the last one hundred years or more. In the words of Carlyle, "History is the basis of all true education," and some knowledge of the past is essential to a proper understanding of the present. They have accordingly described what was done in the past, and what is being done in the present, believing that facts will be found more useful than theories.

In the earlier chapters of the volume they have briefly indicated the principal landmarks which appear in the path of progress during the last few centuries, especially in connection with the actual working of the coal; they have traced up to the present time the general rise in wages, the improvement in the condition of the working miner, the variations in the cost of working, and in the market value of coal.

In succeeding chapters they have given an outline of the duties and qualifications of a Colliery Manager, and of the various grades of under-officials; they have described the daily routine of a colliery, the different classes of labour employed, the method of calculating wages, and the system of wage bills, such as is general in Northumberland and Durham, the district with which they themselves are most familiar. That is the district which justly claims to be the "cradle" of the coal trade, and the *alma mater* of coal-mine engineering—which employs about one-fifth of the entire coal-mining community of Great Britain and Ireland—and which supplies more than one-fifth of the annual output of coal in the country.

In the concluding chapters they have dealt with the principal methods of working coal seams as practised at the present time—namely, the Bord and Pillar, the Longwall, and the Double Stall—describing in practical detail examples which have come within their own personal ken.

Underground the photographer works at a disadvantage, more especially in *coal*-mines, and has to take what he can get rather than choose what he would like; but it is hoped that the photographs reproduced in this volume may convey a true idea of some of the ordinary conditions of an average coal-mine, and of the *personnel* employed.

In the APPENDIX will be found the text of various documents illustrating either the past history or the present conditions of coal-mining, in addition to others freely scattered throughout the body of the work. It will be seen, therefore, that the subject-matter of the volume in every section is derived from trustworthy material; and inasmuch as the authors have dealt here with subjects with which their own personal experiences and professional avocations have made them long familiar, and have spared no pains in executing their task, they trust that the outcome of their joint labours may prove a useful and acceptable addition to coal-mining literature, and of some permanent value to many of those who are interested in the subject.

H. F. BULMAN,
Byer Moor, Burnopfield, R.S.O.
Co. Durham.

R. A. S. REDMAYNE,
Seaton Delaval, Northumberland.

September 1896.

NOTE TO SECOND EDITION.

FOR this new edition of "COLLIERY WORKING AND MANAGEMENT," the original existing text has been revised; the statistical and legal matter has been brought up to date; and much new matter added, the result being that the volume has been enlarged by nearly 100 pages.

It may be well that the Authors should again emphasise what was stated in their original Preface—namely, that they have purposely confined themselves to the Organisation and Payment of Labour and the actual Working of Coal Seams, as being the subjects which have received as yet less attention than any other in Mining literature. Great as are the advantages to be derived from the adoption of suitable mechanical appliances, yet machines must be controlled by men, and human skill and human character are, and always will be, the chief factor in the successful operation of collieries, as of other industries. Labour is responsible for more than one-half of the cost of coal-getting; and the efficient organisation, control, and superintendence of labour constitute certainly more than one-half of the useful work of the Colliery Manager.

Objection was taken in certain quarters to the First Edition of the work, on the ground that it dealt too exclusively with colliery working in Northumberland and Durham. Since the work first appeared, both Authors happen to have had special opportunities of becoming more closely acquainted with colliery working in other British coalfields, and in the present edition they have endeavoured to extend the scope of the book by more particularly devoting what additional space was available to other districts. Amongst the additions thus made will be found detailed descriptions of modes of working in Staffordshire and in South Wales (Chapters XV. and

XVI.); while the tabulated statistics of various collieries in different districts which are now given for the first time (see Chapter XVII.) afford useful data for instructive comparisons and deductions.

The new final chapter—on "The Colliery Manager and the Law"—is a valuable and interesting addition to the volume, for which the Authors are indebted to Mr. R. M. JOHNS, of the Middle Temple, whose acquaintance with the subject is based in part on his experiences some years since, when engaged in the responsible control of a large Colliery enterprise in the county of Durham.

H. F. BULMAN,
Leazes Hall, Burnopfield.

R. A. S. REDMAYNE,
The University, Birmingham.

March 1906.

CONTENTS.

CHAPTER I.

EARLIER METHODS OF WORKING COAL - - - 1

CHAPTER II.

WORKING COSTS AND RESULTS—PAST AND PRESENT - 15

CHAPTER III.

CONDITIONS OF LABOUR IN COLLIERIES—PAST AND PRESENT - - - - - - 31

CHAPTER IV.

THE PRACTICAL MANAGEMENT OF A COLLIERY - - 48

CHAPTER V.

SUPERINTENDENCE OF LABOUR AT A COLLIERY - - 64

CHAPTER VI.

ARRANGEMENT OF LABOUR AND SYSTEM OF WAGES - 74

CHAPTER VII.

WAGES BILLS AND COST SHEETS -

CHAPTER VIII.

PAGE
TOOLS AND APPLIANCES USED IN COAL-GETTING - - 108

CHAPTER IX.

DIFFERENT SYSTEMS OF WORKING—SOME COMMON CHARACTERISTICS - - - - - - 135

CHAPTER X.

WORKING BY BORD AND PILLAR - - 150

CHAPTER XI.

REMOVAL OF PILLARS AT DIFFERENT DEPTHS - 177

CHAPTER XII.

WORKING BY LONGWALL - - - - - - 197

CHAPTER XIII.

STALL WORKING—DOUBLE AND SINGLE - 222

CHAPTER XIV.

ON WORKING TWO SEAMS NEAR TOGETHER - - 237

CHAPTER XV.

THE WORKING OF THICK SEAMS - 241

CHAPTER XVI.

THE WORKING OF WELSH COAL SEAMS 255

CHAPTER XVII.

CONDITIONS AND RESULTS OF WORKING IN DIFFERENT DISTRICTS COMPARED - - - - - 262

CHAPTER XVIII.

THE COLLIERY MANAGER AND THE LAW 293

APPENDIX.

PAGE
I. Comparative Cost of Working Bord and Pillar and Modified Longwall at a Large Colliery - - - 307
II. Coal Mines Regulation Act, 1887. Official Abstract, including the General Rules under the Act - 312
III. (A) Form of Special Rules established under the Act 332
(B) Special Rules for the Installation and Use of Electricity (Issued by the Home Office, 1905) - 348
IV. Pitmen's Yearly Bonds (not now in use):—
Bond dated 23rd November 1767 - - - - 360
Bond dated 20th November 1779 - - - 362
Bond dated 19th March 1859 - - - - 363
V. Forms of Hiring Agreements (Three Forms) - - 368
VI. Forms of Cavilling Rules (Three Forms) - - 377
VII. Joint-Committee Rules:—
Northumberland Steam Colliery Owners' and Miners' Joint-Committee - - - - 384
Durham Coalowners' Association and Durham Miners' Association Joint-Committee - - 386
VIII. Coal Mines Regulation Act, 1896. Text of the Act - 392
IX. Mines (Prohibition of Child Labour Underground) Act, 1900. Text of the Act - - - - 395
X. Coal Mines (Check Weigher) Act, 1894. Text of the Act - - - - - - - - 395
XI. Coal Mines (Weighing of Minerals) Act, 1905. Text of the Act - - - - - - - - 396
XII. Explosives Order. Summary of its Provisions - - 399

GLOSSARY OF MINING TERMS - - - 401
INDEX - - - - - - - - 409

LIST OF ILLUSTRATIONS.

PAGE

Fig. 1. New Hartley Colliery, Seaton Delaval, Northumberland, 1896 *Frontispiece*

" 2. Plate II. Mouth of a Day-Drift, with group of Coal Hewers - *facing* 2

" 3. " III. Reproduction of Frontispiece of Old Treatise by Mr J. H. H. Holmes on Coal-Mining in Durham and Northumberland, published 1810 A.D. - - - - *facing* 4

" 4. " IV. Reproduction of Plan of Underground Workings made about the Middle of Eighteenth Century - - - *facing* 14

" 5. " V. Putters' Flat, with Back-Shift Hewers going Inbye and Deputy in the Background - - - - - - *facing* 68

" 6. " VI. Deputy Drawing Timber near the Fallen Goaf - " 70

" 7. " VII. A Hewer Kirving in a Thin Seam, and a Deputy Setting Timber - - - - - - - *facing* 76

" 8 and 9. Plate VIII. A Hand Putter at Work; and a Stoneman at Work with a Hand Drilling Machine in the face of a Stone Drift - - - - - *facing* 84

" 10. Sketch illustrating Method of Calculating Cost of Stonework in Slanting a Staple - - - - - - - - - - 85

" 11. Do. do. in Making an Air-Crossing - - - - - 86

" 12. Roads Cutting each other "Cross cut on" - - - - - 87

" 13 and 14. Sketches illustrating Methods of Calculating Price for Kidding - 88

" 15. Do. do. do. for Inclined Stone Drift 91

" 16. Plate IX. Stonemen at Work with Machine Rock-Drills driven by Compressed air - - - - - - - *facing* 92

" 17. " X. Onsetters at Work - - - - - - - " 96

" 18. " XI. A Rolleywayman Boring a Sleeper, and Fore-Shift Hewers coming Outbye to the Shaft - - - *facing* 96

" 19. Hewer's Pick and Shaft - - - - - - - - - 109

" 20. " Shovel - - - - - - - - - - 109

" 21. " Stemmer - - - - - - - - - - 109

" 22. " Scraper - - - - - - - - - - 110

" 23. " Pricker - - - - - - - - - - 110

" 24. " Mall - - - - - - - - - - 110

" 25. " Wedge - - - - - - - - - - 110

" 26. Hand-Drilling Machine - - - - - - - - - 111

" 27. Types of Chains used on Chain Coal-Cutters - - - - 115

" 28. Plate XIX. Messrs Clark and Steavenson's Electrical Coal-Cutter *facing* 116

" 29. Ingersoll-Sergeant Coal-Cutter - - - - - - - - 119

" 30. Do. do. (Section) - - - - - - - 119

PAGE
Fig. 30A. Ingersoll Radial Machine 120
" 30B. The Champion Coal-Cutter 121
" 30C. The Little Hardy Coal-Cutter 122
" 30D. The Champion Coal-Cutter 123
" 31. Gillott & Copley's Coal-Cutter 125
" 32. Section showing Inclined Undercutting 126
" 32A. The Diamond Coal-Cutter 126A
" 33. Hurd Coal-Cutting Machine 128A
" 34. Jeffrey Chain Coal-Cutting Machine 128A
" 35. Sketch showing Arrangement of Air-Compressing Cylinders . . 131
" 36. Sketch of Underground Workings showing Position of Jeffrey Machine at Park Lane Colliery 131
" 37. Blackett's Conveyer 134
" 38. Section showing Coal left to Support Shaft in an Inclined Seam . . 136
" 39. Plan of Shaft Pillars 137
" 40. Bratticing of a Pair of Winning Places 139
" 41-44. Plans showing Different Modes of Face Ventilation of Three Winning Places 140
" 45. Special Case of Face Bratticing in the Presence of a Blower of Gas . 141
" 46. Plate XX. A Deputy on his Rounds coming through a Canvas Brattice Door . . . . facing 142
" 47. Air-Box 143
" 48. Plate XXI. Air-Tubes carried round a Corner, and Ventilating a Single Heading 144
" 49. Pipe Air-Crossing 145
" 50. Wood-topped Air-Crossing in Section 145
" 51. Plan of Top of do. 146
" 52. Brick-Arch Air-Crossing, in Section 147
" 53. Do. do. in Plan 148
" 54. Special Form of Air-Crossing, in Plan 149
" 55. Do. do. in Section 149
" 56. Plate XXII. Face of a Winning Headways, showing Abnormal Thickening of a Thin Seam . . . . . facing 152
" 57. Section showing Reversed Fault 151
" 58. Section explanatory of a Fault 152
" 59. A Form of Fault 152
" 60. Sketch illustrating Method of Drifting between Inclined Seams . . 153
" 61. Do. Method of Drifting through a Fault . . . 153
" 62. Do. do. do. 154
" 63. Levelling Lath 156
" 64. Tee-Bob 156
" 65. Sketch illustrating Mode of Laying-out Underground Curved Road . 157
" 66. Do. do. do. do. . . . 158
" 67. Plate XXIII. Sketch Plan of a Mine Worked on the Panel System facing 160
" 68. Plan of a Square Pillar 161
" 69. Plan of an Oblong Pillar 161

PAGE
Fig. 70. Sketch illustrating Proportion of Coal left in Pillar 162
" 71. Sketch showing Position of Kirving, Nicking, and Shot-Holes . . 162
" 72. Section of a "Place" showing Position of Shot-Hole and Kirving . . 163
" 73. Position of Shot-Holes and Nicking in a Cross-Cut 163
" 74. Sketch illustrating Sump and Back End 166
" 75. Plan of Ventilation in Panel (Non-Gassy) 167
" 76. Do. do. (Gassy) 167
" 77. Do. do. (Very Fiery) 168
" 78. Do. do. do. Coursing Air, two and two . 168
" 79. Plate XXIV. Sketch Plan of Bord and Pillar Workings, illustrating Precautions to be taken in presence of Gas, and in approaching Old Workings containing Water at high pressure . *facing* 170
" 80. " XXV. Plan of Broken Working Bord and Pillar System " 172
" 81. Mode of Regulating Intake Air 174
" 82, 83. Diagrams illustrating Old Pillars 174
" 84. Sketch illustrating Method of Removing Old Pillars . . . 175
" 85. Sketch illustrating Method of Working Pillars at Seaton Burn . 177
" 86. Do. do. do. at Marley Hill . 178
" 87. Do. do. do. at Towneley . . 179
" 88. Do. do. do. at Old Pontop . . 180
" 89. Do. do. do. at Killingworth . . 180
" 90. Do. do. do. do. . . 182
" 91. Do. do. do. at Garesfield . . . 183
" 92. Do. do. do. at Murton . . 184
" 93. Timbering of a Jud 185
" 94. Method of Working Pillars in the Hutton Seam at Eppleton . . 186
" 95. General Plan showing Broken Workings 188
" 96. Barrier Working in the Hutton Seam at Eppleton Colliery . . 190
" 97. Method of Working Large Pillars in the Main Coal Seam at Eppleton Colliery 192
" 98, 99. Sketches illustrating the Results of Altering the Relative Lengths of Bords and Walls 195
" 100. Modified Longwall Working 202
" 101. Timbering in Modified Longwall Working 204
" 102. Modified Longwall Working (another instance) . . . 205
" 103. Plate XXVI. Hewers Working at a Longwall Face in a Thick Seam *facing* 210
" 104. Stone Pillaring and Timbering at Longwall Face . . . 210
" 105. Plate XXVII. Plan of Longwall Workings . . . *facing* 212
" 106. Plan showing Winning Headways 213
" 107. Plan of Pillaring on Longwall Face 214
" 108. Cross-Section of Gateway 214
" 109. Drawing of a Flat showing the Mothergate and Cross-Headings . . 215
" 110. Mode of Forming Cross-Headings 216
" 111. Drawing of a Flat with Headways Mothergates 218
" 112. Plan showing Double-Stall Working 224
" 113. Removal of Ribs in Double-Stall Working 225

PAGE
Fig. 114. Plan of Double-Stall Working at Elemore Colliery 229
" 115. Single-Stall Working in South Wales 234
" 116. Do. do. Cross-Section of Main Level 235
" 117. Plate XXVIII. General Plan of Double-Stall Workings in Graigola Seam, South Wales (1895) . . . . *facing* 236
" 118. Sketch showing the Working of Two Seams near together . . 239
" 119. Example of Bord and Pillar Working 243
" 120. Diagrams illustrative of a "Side of Work" 243
" 121. Plan of Part of Workings of Thick Coal at Sandwell Park Colliery . 244
" 122. Diagram illustrating Pressure on Floor by Roads Driven in Thick Coal 249
" 123. "Hill" System of Working Thick Seams in Warwickshire . 250
" 124. Plan of "Hill" System of Working a Thick Seam . . . 251
" 125. "Hill" System of Working Section, showing Arrangement of Holings 252
" 126. Do. Detailed Plan of Workings 253
" 127. Advancing on Face and on Back Sides of "Slips" 254
" 128. Sketch showing Method of Working Steam Coal Seam . . . 256
" 129. Tram used in Welsh Collieries 257

LIST OF PLATES.

PLATE PAGE
I. NEW HARTLEY COLLIERY, SEATON DELAVAL, NORTHUMBERLAND, 1896 . . . . *Frontispiece*
II. MOUTH OF A DAY-DRIFT, WITH GROUP OF COAL HEWERS . *facing* 2
III. HARRINGTON MILL PIT (ABOUT 1800 A.D.), REPRODUCED FROM HOLMES' TREATISE ON COAL-MINING IN DURHAM AND NORTHUMBERLAND 4
IV. PLAN OF UNDERGROUND WORKINGS MADE ABOUT MIDDLE OF EIGHTEENTH CENTURY 14
V. PUTTER'S FLAT, WITH BACK-SHIFT HEWERS GOING INBYE AND DEPUTY IN THE BACKGROUND 68
VI. DEPUTY DRAWING TIMBER NEAR THE FALLEN GOAF . . . 70
VII. A HEWER KIRVING IN A THIN SEAM, AND A DEPUTY SETTING TIMBER 76
VIII. A HAND-PUTTER AT WORK; AND A STONEMAN AT WORK WITH A HAND-DRILLING MACHINE 84
IX. STONEMEN AT WORK WITH MACHINE ROCK-DRILLS DRIVEN BY COMPRESSED AIR 92
X. ONSETTERS AT WORK 96
XI. A ROLLEYWAYMAN BORING A SLEEPER, AND FORE-SHIFT HEWERS COMING OUTBYE TO THE SHAFT 96
XII. FORMS USED FOR MAKING-UP HEWERS' AND PUTTERS' WAGES BILLS 100

PLATE PAGE
XIII. Form of Abstract Account of Overman's Pay Bill - *facing* 100
XIV. Forms of Abstracts of Costs of Working - " 104
XV. Form of Graphical Statement of Coals Produced and Disposed of Pay by Pay - " 104
XVI. Form of Graphical Statement of Variations in Costs from Pay to Pay - " 104
XVII. Form of Fortnightly Return of Results - " 106
XVIII. Form of Return of Weekly Costs, &c. - " 106
XIX. Messrs Clarke & Stevenson's Electrical Coal-Cutter - *facing* 116
XX. A Deputy on his Rounds coming through a Canvas Brattice Door - " 142
XXI. Air-Tubes carried Round a Corner and Ventilating a Single Heading - " 144
XXII. Face of a Winning Headways, showing Abnormal Thickening of a Thin Seam - " 152
XXIII. Sketch Plan of a Mine Worked on the Panel System " 160
XXIV. Sketch Plan of Bord and Pillar Workings, illustrating Various Difficulties - " 170
XXV. Plan of Broken Workings—Bord and Pillar System - " 172
XXVI. Hewers Working at a Longwall Face in a Thick Seam " 210
XXVII. Plan of Longwall Workings - " 212
XXVIII. General Plan of Double Stall Workings in Graigola Seam, South Wales (1895) - " 236

COLLIERY WORKING AND MANAGEMENT.

CHAPTER I.

EARLIER METHODS OF WORKING COAL.

WHEN one reflects that the British Coal Trade has been in existence for seven centuries—that coal has been worked in this country and sold as an article of commerce since about A.D. 1215, the date of Magna Charta, which gave security to the right of private property—one naturally inquires what progress has been made in the getting of coal during all these years, and what has been the process of development.*

The first step would doubtless be simple digging of the coal where actually exposed at the surface of the soil. In early times, in districts where only a few feet of overlying strata hindered access to the coal, small holes or shafts, 3 or 4 feet in diameter, were put down to the seam and then widened out, so as to allow of the excavation of as much coal as possible without causing the upper strata to fall in. These are known as "bell pits." That this method was followed in very early times is proved by the fact that pits thus fashioned were evidently made in some instances for the purpose of obtaining, not coal but ironstone,* coal adjoining the ironstone having been left,—showing that the work was done before the value of coal was know In the "Buke of Boldon"—an inventory of the estates held b the see of Durham in 1183, when Hugh Pudsey was Bishop—the use of coal† is mentioned several times. The references to i are in connection with grants of land made to certain individual for finding coals. This duty seems usually to have fallen to th smith, no doubt an important village functionary, who require coals "for the iron-work of the ploughs" made by him.

---

* Though the English coal *trade* does not date back earlier than the thirteenth century, coal was known and used long before this. About B.C. 371, Theophrastus, a pupil of Aristotle, mentions in a treatise "On Stones," fossil substances "that are called coals, which kindle and burn like wood coals." "These are found in Liguria and in Elis, in the way to Olympias, over the mountains; they are used by the smiths." This is probably the earliest mention of true coal (not charcoal) on record. The first record of its use in England is often stated to be in A.D. 852, when it is recorded that the Abbot of Peterborough received "twelve cart loads of coal," but it is doubtful whether the Anglo-Saxon word translated here "coal," does not mean "peat." See "The Archæology of the Coal Trade," by T. John Taylor (1852).

In the fourteenth‡ century coal was being mined by shaft an adit, the adit being a horizontal tunnel driven from the surface o some hillside at such a level as to drain off the water from th workings. The coal was raised up the shaft by a jack-roll c common winch moved by manual labour, or by men or wome carrying it on their backs up ladders. Narrow passages wer driven in the coal seam, leaving small pillars to support the roo When difficulties arose from want of air, from too much water, c from crush of the strata, the shaft was abandoned, and a new on sunk not far off, the depth being only a few fathoms. Thus i ancient mining districts, such as West Durham, old shafts may b seen in almost every field—sometimes, indeed, several in one fiel Old plans of Tanfield Moor, a considerable area in West Durha show that there was a shaft to every 10 or 11 acres.

In hilly districts where coal seams "crop out to the day" i the sides of the hills, day-drifts were, and must always remain, th readiest means of access to them. Fig. 2, Plate II., is a photograp of the mouth of a day-drift driven in at the outcrop of a coal sea It shows the strata immediately overlying the seam, and also group of coal-hewers, who have just come out of the mine, and ar on their way home.

During the fifteenth, sixteenth, and seventeenth centuries, fe

---

* See "Ancient Mining at the Coppice, Sedgley," by J. Meachem, jun *Fed. Inst. of Mining Engineers Trans.*, vol. vi., p. 554.

† Whether this was mineral coal, or charcoal, is not certain.

‡ In 1356, Bishop Hatfield of Durham granted on lease five mines in th Manor of Whickham to Sir Thomas de Gray, knight, and Sir John Pulhore rector of Whickham, for twelve years at 500 marks rent per annum (=£333. 13s. 4d £1 in those days would be equivalent to about £20 now). The lessees were t work the mines as far as they could be wrought by five barrowmen, accordin to the view and oath of the chief forester and of the viewers ("par cyn barrowemen par la vewe et serement du chief fforester et des veiours"), an they were limited to one keel a day (probably about 20 tons).—*Archæologi Æliana*, Part 24, vol. viii., of Society of Antiquaries of Newcastle-on-Tyne.

PLATE II

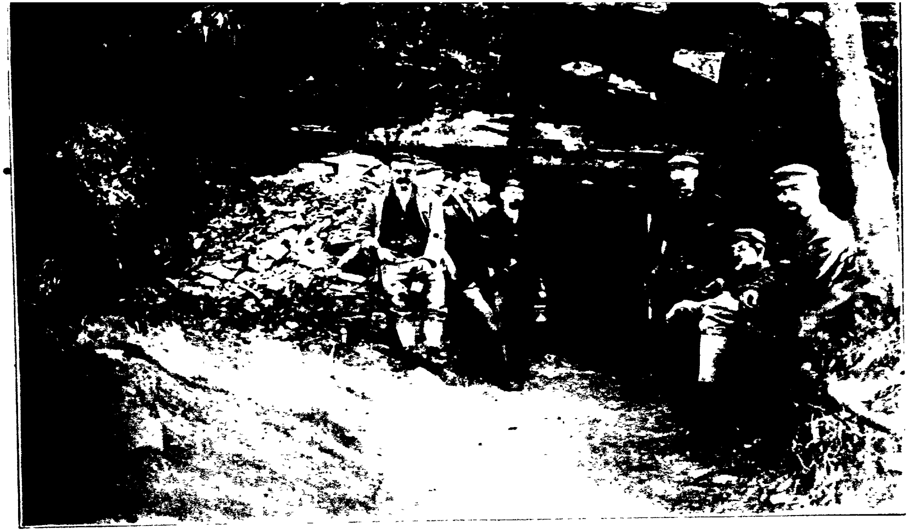


Fig 2 Mouth of a Day-drift, with Group of Coal Hewers

To face page

improvements of any note were introduced. The water being the greatest difficulty, attempts were made to raise it in several stages by chain pumps, operated by water wheels or by horses; and whim gins worked by horses (see A, Fig. 3, Plate III.) were substituted for jack-rolls in raising the coal. The depth of the workings was limited for the most part by the level at which free outlet for the water could be obtained through day-drifts, so that in 1610 it was stated in Parliament that the coal mines at Newcastle would not last out the term of their leases of twenty-one years.

The invention of the atmospheric engine, by Thomas Newcomen, an ironmonger at Dartmouth, in 1710, changed the whole aspect of the industry. At that time 60 fathoms was about the maximum depth of shafts, and their diameter 7 or 8 feet, and the area worked to one shaft was seldom more than 200 yards' radius round the shaft. Fifty years later Walker colliery, on the Tyne, was sunk to the Main coal a depth of 100 fathoms, and in 1763 a pumping engine was erected there, having a cylinder 72 inches in diameter and 10½ feet long. The steam engine was first applied to drawing coals in 1780 at Willington colliery, Northumberland, and the first Boulton & Watt engine, with close-topped cylinder, was erected at St Anthony's, near Newcastle, in 1790.

Deeper shafts and more extensive areas of workings, brought in the era of big explosions, of which we have not yet seen the end. Repeated disasters in the pits led to the formation at Sunderland, in 1813, of "A Society for Prevention of Accidents in Coal Mines," and it was the members of this society who were instrumental in engaging Sir Humphry Davy in the exertions which, in 1815, culminated in the invention of his safety-lamp.

As regards the working of the coal, it would soon be found that planes of cleavage run through the seams in two directions at right angles to each other—roughly, north and south, and east and west, in the Newcastle coal-field—and that the cleavage in the former direction is more pronounced than that in the latter. Roads, therefore, can be most easily cut in an east-and-west direction, or at right angles to the main cleavage planes. These ways came to be called "bords"—a term said to be derived from an old Saxon word meaning a road or way. In the eighteenth century these bords were usually made 3 yards wide, and pillars of coal, 4 or 5 yards wide, left between them. In an old paper bearing date 6th [illegible] 1768, and headed "Mems. of Urpeth and Ouston Colliery, by

Wanless," it is noted:—"*Middle West Pasture Pit.*—Wrought in the Main Coal, and not in the walls; 8 yards to a winning; bord 3 and wall 5 yards. The north headways driven about 19 winnings or 152 yards; the Mothergate Westward 7 pillars at 30 yards to a pillar, the first and second pillars = 20 yards, so that the Mothergate Westward will be 190 yards west." The term "wall" is used to denote both the passage between the bords at the end of each pillar, and also the width of solid coal or pillar measured along the headways—that is, between the bords—and this width, *plus* the width of the bord, is termed a "winning." As (in the instance just cited) the headways advances every 8 yards, room for another bord is "won out." The temptation of making walls thin, in order to get a number of bords won out quickly, is apparent. Judging from old "views" dated about the middle of the last century, it was usual to get as much coal as possible in the first working with little consideration for a second working of the pillars. For instance, in a "view" of Murton colliery, near Berwick-on-Tweed, dated 11th November 1754, the viewer states: "I find the men win about 7 yards of headways to a winning, and take 3 yards of that for a bord, and leave 4 yards for a wall, and hole these walls at 4 yards long, so that the pillars are a square of 4 yards the side. . . . By the above method of working there is a great quantity of coal lost, for they cannot make a second working. Therefore I recommend for the future that the bords be driven 4 yards wide, and the headways twixt 4 feet 6 inches and 6 feet wide, and the pillars left 20 yards long and 4 yards thick, by which method there may be a second working, and the coal will work much rounder, for these pillars will probably prevent a thrust at any time when working the broken mine, and in all probability near six-eighths of the coal may be got, whereas by present method of working not more than two-thirds is got." Again, in "A View of Ravensworth Colliery, taken 18th May 1742," we read: "The Bridge Pit is working in the Top Coal, the seam 5 feet 6 inches, out of which thrown out as stone and refuse 4 inches. They take about 8 yards to a winning, take 4 and leave 4, but as it appears on measuring the bord, they don't work very regular."

"Mothergate" is a term which is often found in mining reports [illegible] "views" of pits of the last century, but it has become almost [illegible] in the bord-and-pillar system of working. It is still used, [illegible], in longwall. It meant a main road in an east-and-west [illegible], along which the coals were brought out, the term now [illegible] "trolleyway bord" or "going bord." The length of a

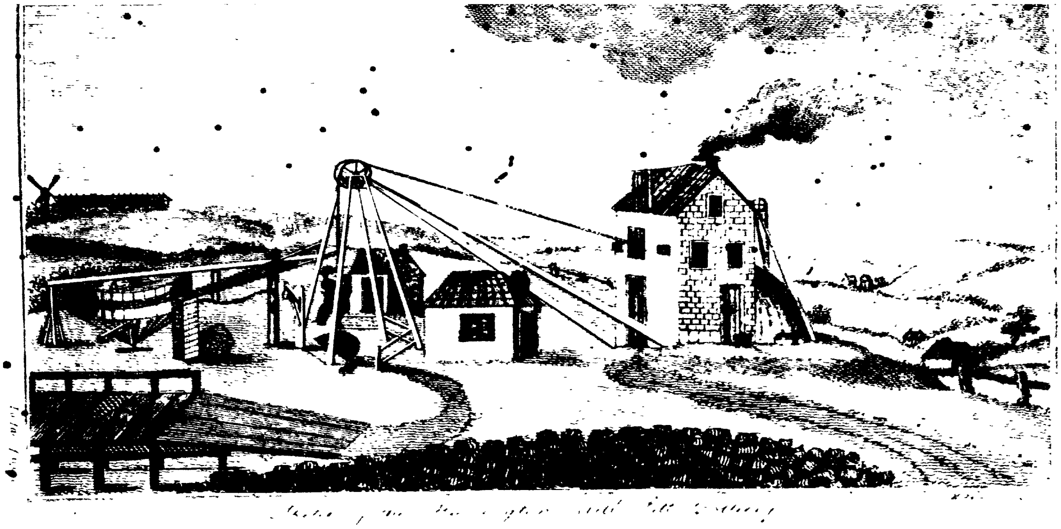


Fig. 3 — Reproduction of Frontispiece of Old Treatise on Coal Mining in Durham and Northumberland by Mr J H H Holmes published 1816

bord is usually the length of a pillar. The solid coal left is vario spoken of as "walls" or "pillars." Thus, in "A View at South H ley Colliery, for Mr Maddison and Pts., by William Unthank a John Allon," dated 18th November 1769, the viewers report follows: "As the Five-quarter Coal Seam is the uppermost se to be wrought there, the regular and best way of working it is, our opinion, that the lessees begin to work that part of it whi lies to the east of the Prosperous Dyke first in the whole coal a then in the *walls and pillars*; after that to begin on the west si of the Prosperous Dyke, and work away the whole coal if there any, and then the *walls and pillars* to the rise, securing the sa watercourse."

As pits got deeper, it was found necessary to make the pill wider, in order to resist the crush of the overlying strata, whi operates in two different ways, known respectively as "**creep**" a "**thrust**." "Creep occurs when the area of pillars is not suffic to support the superincumbent pressure, and the floor (or "thill of the seam is *soft*. The pillars are then forced downwards, and th floor "rises" where the coal has been removed, until floor and ro come together. This movement goes on until all the excavatio are filled up, no timbering for the support of the roof being stron [illegible] to resist an extensive creep. Districts of pillars sever [illegible] extent have been known to creep tight in a single da [illegible] was not an uncommon occurrence in the early part of th [illegible]ury and the latter end of the last. "Thrust," on the oth hand, is the term used to describe what occurs when there is no sufficient support for the superincumbent pressure, and [illegible] the floor of the seam is *hard*, and does not rise in the [illegible] walls, as in creep. In thrust, therefore, the pillars are crushed, [illegible] the result that the coal is rendered worthless; whereas large areas "crept" pillars have been subsequently opened out, and the coal

John Buddle, who is sometimes called the Father of [illegible] Engineers, writing in 1834, relates [*] that in working the Main seam at Wallsend colliery, at a depth of 226 yards—the thick of the seam being 6 feet 6 inches, and the pillars 8 to 10 yards by 22 yards long, with bords 4 or 5 yards wide—a creep which shook severely the village of Wallsend on the su that in subsequently working the Metal Coal seam, which 16 yards below the Main Seam, the Metal Coal was broken and forced upwards below all the old bord rooms in the Main Seam, so that it could not be worked to profit.

---

[*] John Buddle on "Mining Records," *Proceedings* [illegible]

Mr R. L. Galloway* tells an anecdote of what occurred at Longbenton church (Longbenton is a village about four miles from Newcastle-on-Tyne) in the early days of the century. During the service one Sunday, the congregation were so much disturbed by pieces of plaster falling from the building, and other signs of movement, that they gradually dispersed, leaving the vicar alone, in spite of his repeated assurances that "it was only a creep; only a creep."

Mr J. H. H. Holmes,† in a book published in 1816, mentions that when working one of the seams in the Harrington pit, a creep occurred, "which caused a rent through the whole upper strata and alluvial earth to the surface through near 100 fathoms in thickness."

Under the system of working which was general in Durham and Northumberland, until the present century was well advanced, creep and thrust were imminent dangers in the deeper mines. Consulting viewers used to be called in to advise what was the smallest amount of coal necessary to be left to prevent creep. It was the fear of thus losing the colliery—combined with the great difficulty, in gassy mines, before the era of safety lamps and improved ventilation, of removing the gas sufficiently to prevent explosions—which hindered the working away of the narrow coal pillars then universal.

The state of a gassy colliery at the beginning of this century is well illustrated by an authentic account of what the famous John Buddle was accustomed to do at Wallsend colliery, as related by the principal performer, one Anthony Sharp, afterwards "keeker" at Kibblesworth colliery. The scientific and humanitarian interest which was beginning to be awakened in connection with coal-mine explosions, and Mr Buddle's reputation, brought to Wallsend many visitors of various degrees, from Russian Czars downwards. Not far from the bottom of the shaft, Mr Buddle had prepared an opening of considerable height and size, where gas was nearly always found lurking next the roof. This chamber served as a laboratory for the practical demonstration of a pit explosion on a small scale, as described in a local newspaper some years ago. 'The *modus operandi* was as follows:—When a party was expected, Mr Buddle would say, 'Now, Anty, dis thoo think thoo can give us a crack the day?' 'Wey, aa'll try,' was Anty's usual reply. After getting 'belaa' with infinite care at the proper time, Anty would go forward a little into the chamber already described, with a lighted tarry rope-end in his hand, Mr Buddle and his visitors following. At the proper place, swinging his extemporised torch around his head, he would throw it up as high as possible, and then, flinging himself flat upon his face, would there await results. The explosion almost invariably occurred, sometimes with greater force than even Mr Buddle bargained for, and as the noise echoed and re-echoed through the workings, the party generally concluded that they had had enough of coal mining for that day at least, and were glad to be hauled up the shaft again to fresh air and safety."

---

* "A History of Coal Mining in Great Britain," by R. L. Galloway.

† "Coal Mines of Durham and Northumberland," by J. H. H. Holmes.

As recently as sixty years ago, the condition of a large fiery mine must have been deplorable. On the day previous to a great explosion at Wallsend (a colliery under the most skilled management of the day—a great financial success), in the year 1835, whereby 102 persons lost their lives, the pit was in so dangerous a state that a hewer named John Bell, and five men working with him, were obliged to come away, extinguishing their Davy lamps, which had already become red hot. According to the report of the "South Shields Committee for the Investigation of Accidents in Mines" (formed in 1839), "on the morning of the explosion, before Bell left work at eleven o'clock in the forenoon, all the six Davys were on fire." To take another instance, at Lord Dudley's Netherton pits, in South Staffordshire, it was customary at the beginning of this century to regularly remove the gas three times a day—at 4 A.M., at noon, and at 7 P.M.—by *burning* it.

The art of coal-mine ventilation has only reached its present more satisfactory condition through long years of struggle with great difficulties and dangers. A coal mine naturally emits poisonous and dangerous gases. To keep the atmosphere pure, and fit for the healthy existence of men engaged in vigorous physical exertion, through miles of confined passages, which too often can only be kept open by constant labour and watchfulness, is no easy problem. Of the pioneers in its solution the names of Spedding, Buddle, and Atkinson are prominent. Carlisle Spedding had charge of Sir James Lowther's collieries at Whitehaven in the early part of the eighteenth century, and under his able management many improvements were introduced. He was the inventor of the "steel mill," the earliest attempt at producing an artificial light which would not explode firedamp. About 1760 his son, James Spedding,* who succeeded him in the management of the Whitehaven collieries, introduced "coursing the air" in place of "face airing." Hitherto it had been usual to confine the air-current to the working face, leaving the numerous passages already made to take care of themselves; and consequently in fiery seams they became filled with gas, which on a fall of roof, or decrease in atmospheric pressure, was forced out into the working faces. James Spedding, by means of stoppings and doors, caused the air to flow up and down these passages after passing the working face, thus clearing away the gas, if the air-current was strong enough. At Walker colliery, on the Tyne—a colliery of great renown a hundred years ago—the air was carried in one current through a distance of about thirty miles. Matthias Dunn, in his book on the "Working of Collieries" (published in 1848), stated that "during many years the practice of maintaining one continuous column of air throughout the whole workings prevailed, so that it was no uncommon occurrence for the air to travel thirty or forty miles from leaving the downcast pit to regaining the surface." This system was soon found to be inadequate for ventilating extensive workings in fiery mines. The friction due to the great length of airway was very great, and as the current was accumulating gas all the way, it was sometimes in a dangerously explosive state on reaching the furnace, then the only ventilating power used.

---

* There is some uncertainty whether Carlisle Spedding, or his son James first introduced "coursing the air."

It was under these circumstances that Mr John Buddle was led to introduce the system of dividing or splitting the air-current into several smaller currents, by the aid of air-crossings and regulators, and of dividing the workings into separate districts by leaving barriers of coal between. By this means each district gets a supply of fresh air, and the resistance which the air current has to overcome is much reduced, so that the same ventilating power produces a larger total volume of air.

Atkinson devoted his mathematical genius to the elucidation of the laws which govern the flow of air through mines, determining the relation of the volume to the resistances with which it meets, and to the power producing it. In a series of masterly papers, which may be found in the early volumes of the *Transactions of the North of England Mining Institute* (1854 to 1863), he laid for the English-speaking races the scientific basis of modern mine ventilation.

The practical test of a well-ventilated mine is the condition of the atmosphere at the coal face, and wherever men are at work. With modern appliances it is easy to have large volumes of air flowing along the main roads; but to ensure that throughout the ramifications of an extensive mine every individual shall be surrounded by a healthy atmosphere, requires in deep and fiery mines the exercise of knowledge, care, and ingenuity.

At the beginning of the present century, according to Mr Buddle,[*] the maximum produce of a fiery seam, attainable under any mode of working, was considered to be 45½ per cent., the pillars being made 6 yards by 22 yards. At Walker colliery, in 1795, Mr Thomas Barnes partly worked some pillars in a fiery seam as follows:—He formed the old workings into districts of 10 to 20 acres in area, by stowing with stones the bord rooms and walls surrounding it, so as to form a solid barrier of 40 to 50 yards in breadth. Five yards width of coal was then removed from each end of every pillar, leaving only 10 yards by 6 yards of coal standing. The artificial barrier hindered creep from spreading to the adjoining pillars. This plan was adopted at Wallsend, and other of the adjoining collieries. Mr J. H. H. Holmes, F.S.A., in his book already mentioned, states that "the Wallsend coals are so valuable, that Mr Russel [the owner] is taking away all the coals, and substituting stone walls." In 1809 Mr Buddle improved upon this by leaving barriers of solid coal round each district, an arrangement known as "panel work."

The date at which it became customary to remove pillars formed by a previous working has been a point of some importance in determining claims for damage to the surface, and many such claims in which the point arose have led to legal proceedings. That damage of the kind was done at an early date is proved by the records of the Halmote Court for the County of Durham. Early in the fifteenth century, there was an inquiry before that court about a case which had occurred in the parish of Whickham, as to which it is recorded: "It is found by the jury that John de Penrith is injured by a coal mine of Roger de Thornton, so that the house of the said John is almost thrown down, to the damage of the said John of 20s. assessed by the jury; therefore it is considered that the said Roger repair the said house to the value aforesaid, or satisfy the said sum."[†] And a century and a half later, in a lease from Queen Elizabeth to Sir Nicholas Tempest of coal mines in Stella, it was stipulated that sufficient pillars ("columnæ vel pillers") should be left to support the roof.[‡]

The "Compleat Collier," a small work which was published in

---

[*] Mr Buddle on "Mining Records, 1838."

[†] "History of Durham," Francis Whellan & Co.

[‡] T. J. Taylor's "Archæology of the Coal Trade."

1708, bears beyond dispute internal evidence of having been writte by some one well acquainted with the practical working of collieri in "northern parts" about that date. In that work, describing th system of working, the author says: "And in this method it that we carry on this coal work, taking away 3 yards or bette according to the strength or softness of the coal, and leaving 4 yard standing for pillars to support the roof and weight of the eart above." The depth is assumed to be 60 fathoms. There is n mention in the pamphlet of any subsequent working of the pillar This is strong evidence that at that date it was customary to leav more than half the seam standing in pillars, and that no attemp was made to remove the pillars. The pamphlet was cited as testimony to this effect by Mr G. C Greenwell in his evidence in th case of *Shafto v. Bolckow, Vaughan, & Co and the Ecclesiastica Commissioners for England*, tried in April and May 1888.

In the old shallow mines the pillars were small, and frequentl no attempt was made to remove them. When seams lying at greate depths came to be worked, larger pillars were required, and more coa was therefore lost if they were abandoned, and the practice of thinning or splitting them became general. The amount that might be taken off the pillars was a question which received careful consideration. Five viewers, who reported on Byker colliery in 1746, wrote: "We, whose names are underwritten, have viewed Byker Colliery, and finde ye same to be fairly and regularly wrought, 9 yards to ye winning, ye pillars 5 yards thick, and to ye best of our opinion there may be three-quarters of a yard taken off the walls in the Hagg and Bird Pits, and one yard taken off the walls in the Chance, Speedwell, and Virgin Pits." They kept themselves safe, however, by adding: "When this is done, we cannot certify the Colliery will be upstanding."*

Mr Matthias Dunn, in his book on the "Coal Trade" (1844), states that "the working away of pillars in the fiery collieries was first practised at Chartershaugh, on the Wear, in 1738, Edward Smith being then viewer." Mr Nicholas Wood, speaking in 1860, said: "Pillars were taken away at a very early period. I have reports as far back as 1740 or 1750, and upwards, as to mode of taking away pillars, and have travelled in Old Benton Waste, where large districts of pillars have been worked entirely away. Benton was abandoned somewhere before 1765, so that before 1765 there must have been a very extensive system of taking away pillars. If you inquire of old people, they say it was the practice to leave pillars till they got to the extremity, and then they came back and took them away. The records of very old collieries show that it was the practice to take away pillars." And again: "The great difficulty, before the lamp was invented, was to know how much you could take away with candles, and whether, after taking away a certain quantity, you could take away more without producing a creep."*

---

* "Archæology of the Coal Trade," by T. J. Taylor, from *Proceedings of Archæological Institute*, Newcastle-on-Tyne, 1852.

One Luke Curry, writing on 3rd October 1757, states: "I have this day viewed Ford Colliery (Northumberland), and find that they have by working the walls or pillars of the said colliery in an irregular manner brought a thrust upon their watercourse for 130 yards in length," &c.

In a report on Copley Bent colliery, dated 11th July 1780, it was stated that "a barrier of whole coal should be left to support the roof, instead of which the pillars have been wrought, and thrust brought within 2 yards of the water-level."

From documents in the Durham Chapter offices, the Low Main seam appears to have been worked under the Durham Grammar School so far back as 1623, and scarcely any coal left.

In a "Copy of a View at Mr Carr's Colliery, Birtley, by Anthony Waters and William Unthank, dated the 17th June 1767," the viewers state: "We this day viewed that part of Birtley Colliery belonging to Mr Strother Carr, and find the Peggy Pit working the walls in the Maudlin Coal towards the west in a regular manner. That towards the east, it appears the walls of the Maudlin Coal are wrought. The barroway from the Peggy Pit is in some danger of running together, which should be taken care of and prevented, so as the walls towards the west as far as the Ash Pit may be brought thereto, and as far farther west as shall be thought proper. . . . And we are of opinion that the said Maudlin Coal Walls may be wrought with the least hazard at present of bringing down the feeders of water in the Upper Main Coal, and ought to be wrought before any walls are touched in the Low Main Coal and Hutton Seam in the east part of the colliery." The expression "working the walls in a regular manner," in this document, seems to imply that it was customary at that date to remove the pillars in the shallower collieries which were free from gas, and this is confirmed by the old reports already quoted.

---

* *Transactions of North of England Mining Institute*, vol. ix., p. 32.

In estimates dated 1766, and now extant, of the probable amount of workable coal to be obtained from a given area, a fourth part is allowed for as left.

In old collieries it is not unusual even now to find districts of old pillars, only a few yards in width, which have been abandoned by former workers. The period of advance towards larger pillars and their entire removal is indicated in the following extract from a report dated 4th March 1791:—"*Copy of Mr Ramsay's report of Ramshaw Colliery.*—Then descended a pit in this colliery to the Main Coal Seam at the depth of 13 fathoms. Height of the seam, 5 feet 4 inches of merchantable clean coal. On examining the workings, find the same irregular, the winnings being made at 5, 6, and 7 yards, and the bords drove in breadth from 3½ to 4 yards; also the pillars are in length from 10 to 20 yards, and from this mode of working nearly one-third of the mine is left, as the pillars now standing are too small to admit of a second working. On viewing the seam in consideration of the lightness of cover, I think it advisable in the New Pit, which is now sinking, to make the winnings at 8 yards, and the length of the pillars 20 yards, to make a second working, if the coals can be made merchantable. By this mode of working, a greater quantity of coals will be obtained, which will be a profit both to the Lessor and Lessee."

The advantage of leaving wide pillars, amply sufficient to prevent creep or thrust during their removal, does not seem, however, to have been generally realised until the present century had well advanced. In many cases the pillars were "robbed" (to use a technical expression)—that is, partially removed—either by driving a narrow place called a "jenkin" through the pillar in a bordways direction, leaving a foot or two of coal on either side, or by taking off lifts at each end. The old workers seem to have had a strong objection to letting the roof fall, and the evidence goes to show that the practice of leaving large-sized pillars, with a view to removing them *entirely* in a second working, became *general* only about sixty years ago.

In a report on Fallowfield colliery, dated 10th November 1828, Mr Nicholas Wood stated: "On inspecting the workings I found they were pursuing the mode, almost universally practised in the district, of making the winning 9 yards, taking out or working as a bord 5 yards, and leaving unwrought or standing 4 yards as a pillar; and, as it does not seem to be the practice to work the pillars out afterwards, four-ninths of the coal is therefore lost. When the coal is drained by engine power, and when in working the pillars there is a risk in raising water, which by overpowering the engine might endanger the permanent safety of the colliery, it is often advisable to leave the pillars. But when the coal is drained by a free water-course, as in the present case, and no such risk can therefore occur, it is quite practicable by pursuing a different mode of working to obtain the whole of the coal, which, while it produces to the landlord four-ninths more coal, is not incompatible with the interests of the tenant. . . . The principle on which the colliery has hitherto been worked, not only during the present take, but in all previous ones, has been with a view of not obtaining the coals left as pillars, and this has been sanctioned by the custom of the district."

In a report made by Messrs G. Johnson and N. Wood in November 1823, they recommended that in "winning out to the north a thick wall or barrier of 40 yards in breadth be left at intervals of every sixteen bords. . . . And in general, as from the peculiar situations of the different royalties a working of the pillars must be resorted to at no distant period, we would direct the attention of the viewer to the expediency of leaving sufficient barriers, that he may be able to obtain not only the greatest quantity of coal, but also in the greatest perfection.

Messrs Easton and Dunn, in a report made in 1827, write as follows: "The width of the excavations, and the quantity of coals to be obtained by the first working, form a very important feature in the management of so extensive a mine as this; and are very much governed by the future practicability of taking away the pillars." And "as no question can exist of the advantage of large pillars for the effectual working of them," they went on to recommend the addition of 1 yard to the width of pillar. They continued: "In order generally to provide for such pillar working, districts should be preserved by coal or other barriers of from 8 to 15 acres in extent, as circumstances may point out; where defended by coal only, the barriers to be left from 40 to 60 yards."

Reporting on the working of the Main Coal seam at Hetton colliery in 1832, Messrs G. Johnson and N. Wood recommended that the winnings should be increased from 14 yards to 16 yards—viz., 12 yards for the pillar and 4 yards for the bord—"taking into consideration the depth of the seam and the nature of the coal."

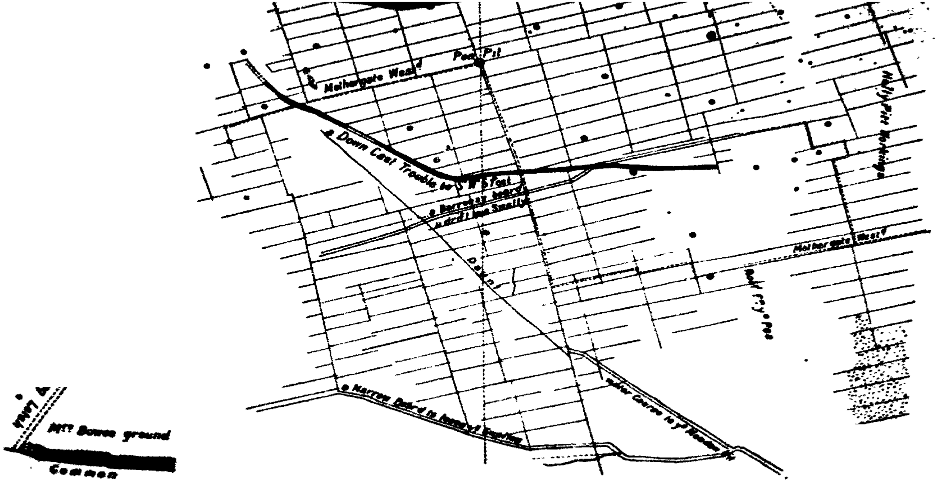
Where pillars had been left, it was customary to apply to the mining agents of the lessors for permission to work them, and this permission was only given in some cases on certain conditions, such as building stone pillars over a certain area, to "prevent the progress of the weight."

From the various extracts given above (and many more to the same effect might be added) we learn that as the result of the slow evolution of practical experience, and of increased facilities of lighting and ventilation, important improvements in the bord and pillar system of working were introduced in the period about 1830-40—namely, a greater width of pillar; and in the deeper and fiery mines the isolation of districts by leaving barriers of solid coal round them, to be removed subsequently; thus, by these means getting eventually the whole of the seam.

The following up of the whole by the broken—that is, the working of the pillars close behind the first working in the whole coal—was also practised early in the century. Mr Nicholas Wood, reporting on Tanfield Moor colliery in 1836, wrote: "The mode now almost universally practised, whenever circumstances will allow, is to make the partial working and taking away the pillars one operation; or take off the pillars immediately following the first working."

Summing up, the documentary evidence cited goes to show that, previously to 1708, the general practice was to leave small pillars of coal standing for the support of the roof; thirty years later, pillars were being partially, sometimes entirely, removed, and during the remainder of that century in mines free from gas a second working of the pillars was frequently carried out. In the deeper and fiery collieries, which began to be developed about the middle of the eighteenth century, the risk of creep, as well as of gas explosions, prevented the removal of the pillars. The invention of the safety-lamp, improvements in ventilation, and the formation of much larger pillars in the first working, were changes for the better which were introduced during the first thirty to forty years of the present century, and which enabled the pillars to be removed in a second working—sometimes immediately following the first, and sometimes deferred for a considerable period, according to circumstances.

The annexed plan—Fig. 4, Plate IV.—which is a reproduction (on a reduced scale) of the original in the authors' possession, made about the middle of last century, shows the workings at that time of the Pea Pit in Hedley Grounds, in the county of Durham. It may be regarded as a fair specimen of the sort of pit plan then in vogue at North country collieries. The pillars vary a good deal in length, but in width are regular, the winnings being 10 yards. Dotted lines are freely used as distinctive features, indicating both the main roads and the north line. There is no indication of pillar working, unless the dotted area in the bottom right hand corner is meant to indicate goaf.



A Plan of the Workings of the Pea Pit
in Hedley Grounds.

Fig. 4.—Reproduction (on reduced scale) of Plan of Underground Workings made about the middle of the Eighteenth Century.

To face page 14.

CHAPTER II.

WORKING COSTS AND RESULTS—PAST AND PRESENT.

WORKING COSTS.

As regards the cost of working coal, the following is a summary of some instances taken from old papers and reports in the authors' possession, covering a period of over seventy years, from 1763 to 1836. In most cases, further details or copies of the documents from which the particulars have been taken are given subsequently.

County.	Name of Colliery.	Date.	Cost per Ton.			Remarks.
			s.	d.		
Northumberland	Longbenton	1763	1	7½	In the Whole	This does not include anything for rent, taxes, or materials.
			1	3¼	In the Pillars	Do.
Durham ...	Tanfield Moor	1771	1	5	Hard Coal Seam	Rent and taxes not included.
			0	11¾	Hutton Seam	
Northumberland	Walbottle ...	1771	1	10.3	... ...	Do.
Durham ...	Mount Moor	1790-95	1	9.3		
Do. ...	Brandon High Colliery	1796	2	11	... ...	Including 3.3d. per ton for rent, but nothing for materials.
Northumberland	Willow Bridge	1819	3	0	... ...	Includes rent, taxes, materials, and all cost for putting into waggons at the pit.
Durham ...	Mount Moor	1827	4	2	... ...	Do.
Northumberland	Acomb ...	1827	3	3½	... ...	Do.
Do. ...	Montagu Main	1827	4	0	Pillar working	Do.
Durham ...	Blackboy ...	1832	4	6	... ...	Do.
Do. ...	Witton Park	1834	2	7½	... ...	No rent included.
Do. ...	Pittington ...	1834	4	8	Includes house rents, taxes, materials, and all cost for putting into waggons at the pit (excepting royalty rent).	
Do. ...	Tanfield Lea	1836	3	3½	Includes rent, taxes, materials, and all cost for putting into waggons at the pit.	

If these may be taken as average cases (and the authors know of no reason why they should not), the average cost of putting coal into waggons at the pit was below 3s. a ton during the last century, but the cost increased materially during the early years of the present century.

Coming to more recent times, the cost of putting coals into waggons at the pit mouth per ton of unscreened coals, including all labour, materials, rents, taxes, and incidentals, at three collieries, 1874-79, was as shown in the Tables on the next page.

No. 1 was an old colliery, working two seams, both giving off a good deal of gas—one a seam of house coal, at a depth of 230 yards, varying from 4 feet 6 inches to 8 feet in thickness, with workings extending over a wide area; and the other, a hard steam coal seam of an average thickness of 3 feet, depth 360 yards.

No. 2 was also an old colliery, with widely extended workings in one seam, a steam coal, averaging 4 feet thick, at a depth of 120 yards.

No. 3 was a new colliery, working two seams—one 4 feet to 5 feet thick at a depth of 70 yards, and the other 3 feet to 4 feet thick at 200 yards.

In 1887 the cost of working a hard 3-feet seam at a depth of 80 yards was as follows:—

Unscreened coals vended	81,300 tons.
All labour	3s. 7.30d. per ton.
Materials consumed	0s. 6.00d. "
Incidentals and taxes	0s. 4.44d. "
Rents	0s. 5.65d.
Total cost per ton at the pit mouth	4s. 11.39d.

In 1902 the cost of working several soft seams of coal, constituting a colliery in the Midlands, the seams lying at depths from the surface of from 600, 746, and 859 yards respectively, and being from 5 feet to 5 feet 6 inches in thickness, was as follows:—

Output for the year of all classes of coal	211,003 tons.
Total labour	4s. 8.68d. per ton.
Materials...	1s. 0.87d. "
Miscellaneous charges, including rent	0s. 10.71d. "
Total cost per ton F.O.R. ...	*6s. 8.20d.

---

* This is a high cost due to the fact that wages and price of materials had not yet fallen to the present level, but were still affected by the then recent inflated value of coal.

	No. 1.				No. 2.			No. 3.		
	1874.	1875.	1876.	1879.	1874.	1876.	1879.	1874.	1875.	1876.
Unscreened coals vended	Tons. 64,499	Tons. 70,666	Tons. 53,516	Tons. 66,692	Tons. 81,649	Tons. 95,323	Tons. 97,310	Tons. 77,409	Tons. 80,109	Tons. 77,801
	Per Ton. s. d.	Per Ton. s. d.	Per Ton. s. d.	Per Ton. s. d.	Per Ton. s. d.	Per Ton. s. d.	Per Ton. s. d.	Per Ton. s. d.	Per Ton. s. d.	Per Ton. s. d.
Underground labour and screening	8 5.4	6 11.9	6 7.70	3 0.70	6 3.40	4 7.41	3 5.68	5 3.21	5 1.4	5 4.18
Mechanics	0 11.40	0 8.21	0 8.40	0 4.18	0 11.11	0 5.73	0 4.50	0 5.64	0 6.84	0 6.79
Materials consumed	2 11.61	2 6.02	1 10.36	1 1.06	2 7.77	1 1.72	0 10.76	1 3.25	1 0.61	0 10.65
Incidentals and taxes..	0 3.88	0 2.03	0 4.76	0 2.70	0 3.53	0 3.15	0 2.25	0 1.76	0 1.90	0 2.04
Rents	0 5.60	0 5.63	0 5.26	0 6.00	0 8.00	0 5.28	0 5.28	0 9.00	0 9.00	0 4.18
Total cost per ton at pit mouth .	13 2.04	10 10.72	10 0.63	5 2.73	10 9.87	6 11.32	5 4.47	7 10.86	7 7.84	7 3.84

The figures given in these three Tables suffice to show how much the cost of working varies at different collieries, and what rapid and violent fluctuations sometimes occur in it, even at the same colliery.

The years 1873, 1874, it may be mentioned, were "record" years, in which the cost of labour and materials reached the highest flood-tide of the century, and probably of any previous century, the immediate cause being the Franco-German War. The recoil was as rapid as the spring had been, and in 1879 the working cost of collieries was in many instances one-half of what it was in 1874.

As would be expected, a greater fall took place in the price of coal. In 1873 the price of best coal imported into London was 31s. 3d. a ton at the ship's side, exclusive of dues, while in 1880 it was 14s. 11d.—a fall of 52 per cent. in seven years. The years 1900, 1901, were also "record" years, coal being sold at higher average prices than at any time since 1874.

At the present time (1905) a fair average working cost of putting coal into waggons at the pit bank is 6s. a ton.

The subjoined documents illustrate, and will further explain, the particulars given on page 15:—

I. AN ACCOUNT OF THE CHARGE IN WORKING A TEN OF COALS AT LONGBENTON, 23RD SEPTEMBER 1763.

	In the Whole Mine. Per Ten.	In the Pillars. Per Ten.
For hewing	£0 18 0	£0 9 0
„ driving	0 9 0	0 6 0
„ headways	0 1 6	...
„ setting on	0 0 9	0 0 9
„ trapping	0 1 1½	0 0 1½
„ overman	0 1 10½	0 0 10½
„ sledding	0 3 0	0 3 0
„ corving	0 3 9	0 3 9
„ *drawing	0 15 0	0 13 6
„ *wailing, &c.	0 0 9	0 0 9
„ putting	0 18 0	0 18 6
Candles and oil	0 4 6	0 3 9
Smiths and wrights	0 1 3	0 1 3
	£3 18 6	£3 1 3

At 48 tons to the ten, this is 1s. 7½d. per ton in the whole, and 1s. 3¼d. in the pillars.

II. AN ESTIMATE OF THE CHARGE OF WORKING THE HARD COAL SEAM, TANFIELD MOOR COLLIERY, 9TH OCT. 1771.

			s.	d.	
With a 16† Peck Corf.					
	Hewing	at	2	0	per score.
	Putting in a mean ...	...	1	3	„
	Corving	...	0	3	„
19 bolls to a waggon, and 22 waggons to a ten = 418 bolls.	Sledding	...	0	3½	„
	Overman for headway, and candles, &c. ...	...	0	9	„
16 pecks = 2 bolls.	Driving levels, &c. ...	...	0	4	„
	Props and deals ...	...	0	9	„
If 2 b. : 1 c. :: 418 b. = 10 score 10 c. to a ten.	Shovelling and wailing ...	...	1	3	„
	Drawing	...	1	2	„
	Smith and wright ...	...	0	1½	„
N.B.—The putters with trams have 8d. per score the first change or 60 yards from the shaft, and advance 1d. for every 20 yards after in a mean bord.	Ropes, shovels, &c. ...	...	0	3	„
	Agency, &c.	...	0	3	„
			6	10	„

10½ score to a ten at 6s. 10d. per score is = £3. 11s. 9d. per ten.

---

* "Wailing" is picking the stones from amongst the coals; "drawing," raising the coals up the shaft.

† One peck = 0.3 cwt.

THE CHARGE OF WORKING THE HUTTON SEAM.

With a 24 Peck Corf.

418 bolls to a ten.

If 3 b. : 1 c. :: 418 b. = 7 score per ten.

N.B.—The drivers have 10d. per day through the year.

	Per Score.			Per Score.	
Hewing in the whole	1	8	in pillars	1	2
Putting „	1	6	„	1	6
Corving „	0	3½	„	0	3½
Sledding „	0	3½	„	0	3½
Overman for headway and candles ...	0	5	„	0	6
Driving levels, &c. ...	0	3	„	0	3
Props and deals ...	0	4	„	0	6
Shovelling and wailing	0	3	„	0	3
Drawing	1	6	„	1	6
Smith and wright ...	0	1½	„	0	1½
Ropes and shovels ...	0	2½	„	0	2½
Agency	0	2	„	0	2
	7	0		6	9

7 score a ten at 7s per score = £2. 9s. od. per ten.
„ at 6s. 9d „ = £2. 7s. 3d. „

III. AN ESTIMATE TO TAKE WALBOTTLE COLLIERY BY THE TEN OR SCORE WITH A 16 PECK CORF.

	s.	d.
To hewing by the score with a 16 peck corf	2	0
„ putting with barrowmen or horses, finding horse-geers, drivers, horse-keepers, and attendance	1	6
„ overmanship, with headways, oil, and candles	0	8
„ Trolleys, trams, sledges, and wright works	0	2
„ smith-work and iron geer	0	2
„ wet and double working	0	0½
„ timber and deals, with brick and deal stoppings, &c.	0	3½
„ drawing the coals and rubbish to bank	2	2
„ corving and sledding	0	7
„ ropes and gynns*	0	2
„ fail of stock	0	1
„ driving all winning headways, water-level drifts, above 1s. 4d. per yard, the owner to pay if overplus	0	1
„ examining the waist and shift work	0	1
„ drive levels, set over troubles, pump and lead water to the height of 3 feet or under, if above that to be in the owner's hand ...	0	2
„ finding stuff, make and hang trap-doors, and keeping them ...	0	1½
„ keeping fire-lamps and oil-lamps	0	1
„ wailing and shovelling in the heaps	0	3
„ agents	0	1½
„ lamp coals used at bank and underground and loss of coals ...	0	1
	8	11

At 10 score 10 c. to a ten it will be £4. 13s. 7½d. per ten.

---

* "Gynn" was the machine used for winding the corves up the shaft.

IV. COST OF WORKING BRANDON HIGH COLLIERY, CORNFORTH, 13TH JANUARY 1796.

Per score of 8 Peck Corves.

	s.	d.
Hewing	1	8
Putting	1	6
Headways	0	2
Overman and candles	0	6
Sledding and corving	0	4
Wailing, 4½d.; props, 2d.	0	6½
Smith and wright	0	1½
Drawing	0	6
Interest on money sunk	0	6
Sinking and drifting Unforeseen	0	6
	6	4
Rent	0	8
2s. 11d. per ton =	7	0

V. AN ESTIMATE OF THE EXPENSE OF WORKING WILLOW BRIDGE COLLIERY UPON 2,400 SCORES OF COALS, 21 CORVES TO THE SCORE, WHICH OUGHT TO PRODUCE 2,100 CHALDRONS AND KEEP THE PIT GOING ONE YEAR.

		£	s.	d.
Hewing and putting 2,400 score at 2s. 6d. per score		300	0	0
Driving narrow work		10	0	0
One overman, a part of his time, with house and fire		30	10	0
One bankman, 21s. per week, house and fire, say 50 weeks		57	0	0
Two enginemen, 18s. per week, house and fire, 52 weeks		102	12	0
One gin driver, 1s. 3d. per day for 300 days		18	15	0
Keep of one horse and interest upon his value		40	0	0
Ropes, iron, timber, leather, and all other materials usually included in tradesmen's accounts, also blacksmith's work		100	0	0
Corving and rods		6	0	0
Damage of ground		5	0	0
Colliery rent payable to Lord Barrington	£60 0 0			
" " Vicar of Bedlington	20 0 0			
		80	0	0
Gratuity to Mr Gibbon for surrendering his agreement		30	0	0
		£779	7	0

The quantity of coals to be led above ground for this sum is	2,100 chaldrons
The pumping engine consumes 2 fothers per day for 365 days	243 "
Quantity remaining for sale	1,857 "

Makes the expense for working 8s. 5d. per chaldron, but for the engine coals the expense would be 7s. 5d. a chaldron, and as the water may be expected to continue to abate, probably 8s. per chaldron may be fairly stated as the rate of working for the ensuing year. 8s. a chaldron = 3s. a ton.

VI. MOUNT MOOR COLLIERY. AN ESTIMATE OF THE EXPENSE OF WORKING AND LEADING COALS PER SCORE, FROM FEBRUARY 1790 TO AND WITH 1795.

	SWANG PIT.		SPRING PIT.	GATE PIT.
	High Main Seam, 6 Ton Score, 20 Peck Corf.	Low Main Seam, 4.8 Ton Sc., 16 Peck Corf.	High Main Seam, 6 Ton Score, 20 Peck Corf.	Hutton Seam, 6 Ton Score, 20 Peck Corf.
	s. d.	s. d.	s. d.	s. d.
Hewing	2 3½	2 6	4 0	2 2
Putting from face to crane ...	0 9	0 7	1 8	1 3½
Putting from crane to shaft	1 0½	0 10	...	...
Laying a waggon way 700 yards at 1s. 6d.	0 2	0 1¾	0 1½	...
Cranemen	0 1½	...	0 1	...
Overmen and deputies . .	0 3	0 3	0 5	0 3
Candles and oil	0 3½	0 4	0 4	0 3½
Holing walls	0 2½	0 3½	0 4	0 0½
Barrow way deals	0 1½	0 1½	0 0½	0 1½
Double	0 1	0 1	...	...
Sledges, trams, rolleys ...	0 0¾	0 0½	0 0¾	0 0¾
Setting on	0 1	0 1½	0 1½	0 1
Trappers	0 1	...	0 0¾	...
Fire lamps	0 1	0 1	0 1	0 1
Stoppings	0 1	0 1	0 1	0 1
Air and water courses ...	0 1	0 1	0 0½	0 1
Repairing shaft	0 0½	0 0½	0 0½	0 0½
Engine level drift	0 0½	0 0½	...	0 0½
Smith-work	0 2	0 1½	0 2	0 2
Gins	0 0½	...	...	0 0½
Drawing water to engine level	0 0½	0 0½	...	0 0½
Drawing coals 184 fms. with horses	2 9	75 fms. 2 0	...	87 fms. 2 9
Sledding out	0 4	0 3½	0 4	0 4
Corving, 3½d. per score; finding ropes, 3½d. per score	0 7	0 6¼	0 4	0 7
Wailing and shovelling ...	0 2¼	0 2	0 3½	0 2¼
Engine and workmen's coals	0 4	0 3½	0 2	0 3
Binding pitmen ...	0 3½	0 3	0 3½	0 3
Salaries	0 6	0 6	0 6	0 6
Per score	11 1½	9 10	9 7	9 9¼
Average 1s. 9.3d. per ton =	1 10.1	2 0.5	1 7¼	1 7.5

VII. AN ESTIMATE OF THE EXPENSE OF WORKING THE HUTTON, MAUDLIN, AND HIGH MAIN SEAMS IN THE SPRINGWELL ROYALTY TO THE VALE PIT OF MOUNT MOOR COLLIERY IN FEBRUARY 1827 totals up to £11,027 for an annual vend of 20,000 chaldrons (53,000 tons), including all labour and materials, keep of horses, rents, taxes, and incidentals. This is equal to 11s. a chaldron, or 4s. 2d. a ton.

VIII. AN ESTIMATE OF THE EXPENSE OF WORKING ACOMB COLLIERY, NEAR HEXHAM, DATED 4TH MAY 1827, on an annual vend of 6,240 tons, reaches the total of £1,028. 6s. 8d., including all labour and materials, royalty rents, taxes and cesses, and incidentals. This is equal to 3s. 3.5d. per ton.

IX. THE ESTIMATED COST, DATED MAY 1827, OF WORKING MONTAGUE MAIN COLLIERY, NEAR NEWCASTLE, IN THE HIGH MAIN SEAM PILLARS (depth of seam 36 fathoms), was £14,300 for an output of 13,800 score of 16 peck corves = 66,240 tons = 4s. 4d. a ton. This includes the same items as above, and also 9d. a chaldron = 3.4d. per ton for leading and staith charges.

X. THE COST OF WORKING BLACKBOY COLLIERY in 1832, then the most expensive colliery in the Auckland district, was for "working coals and putting them into waggons at the pit, including rent of mine, agents' salaries, and all other expenses, 12s. per chaldron = 4s. 6d. a ton."

XI. FROM A VALUATION OF WITTON PARK COLLIERY, MAY 1834, BY MESSRS THOMAS STOREY AND JOHN TURNER. "The expense of putting these coals into waggons at the colliery, including all expenses (except rent of mine and a probable expenditure in sinking pits and laying waggon ways), will amount to 7s. per chaldron."

XII. THE COST OF RAISING 19,972 SCORE = 29,958 CHALDRONS = 79,388 TONS OF COALS AT PITTINGTON COLLIERY, NEAR DURHAM, during the first ten months of the year 1834, amounted to £18,563. 13s. 10d., including all labour and materials, £1,332 for house rents, rates, taxes and incidentals, but not royalty rents. This is equal to 12s. 5d. per chaldron, or 4s. 8d. per ton.

XIII. ESTIMATE OF THE EXPENSE OF WORKING COALS AT TANFIELD LEA COLLIERY. Supposed annual vend 20,000 chaldrons (= 53,000 tons).

		s.	*d.*
= 1s. 4d. a ton	Expense of labour expended in laying the coals on bank, including hewing, putting, overmanship, shift work, corving, brakemen, wailing, &c., 8s. per score, with a 20 peck corf, is per chaldron ...	4	0
	Keeping underground horses, 10 at £40	0	4¾
	Main engine, including engineman, fireman, hemp, tallow, and repairs, £350	0	4¼
	Leading workmen's fire coal, gin horses, and other labourage, 4 horses at £45	0	2½
	Joiners, £120; smith-work, £110, masons, including bricks and lime, is £300	0	4
	Keeping machines in repair	0	1
= 3.73d	Materials, viz., props, £400; timber and deals, £100; iron and rails, £100; cast iron, £120; ropes, £70; grease, £35 = £825	0	10
	Agencies and surgical attendance, £400	0	4¾
	Labourers and cartmen leading workmen's fire coal, 3 men and 1 horse-keeper at 12s. per week each	0	1½
= 6.00d.	Colliery rent, 20s. per ten, is per chaldron	1	2
	Poor cess, highway rate, taxes, &c.	0	2
	Sundry expenses, putting through troubles, drifting	0	5
	Multifarious loss by house rents	0	3½
	= 3s. 3½d. a ton per chaldron	8	9¼

SELLING PRICE OF COAL.

Some notice of the market value of coal during the past is not without interest. One of the earliest transactions on record* is a purchase in 1366 of 676 "chalders" of sea coals at Wynlatone for £47. 17s. 8d., by Henry de Strothre, the Sheriff of Northumberland, by order of the King (Edward III.), for works at Windsor

---

* Pipe Rolls, 40 Ed. III., 1367.

Castle. The chalder was at this time probably about 1 ton, as 2 of them went to the keel. The price therefore was 1s. 5d. a ton; bu money is said to have been then about ten times its present valu These coals were brought down the river in "keels" (flat-bottome vessels of very early origin peculiar to the Tyne and Wear, no obsolete) from the neighbourhood of Winlaton to the ships whic carried them to London.*

The total cost in London was £165. 5s. 2d., or 4s. 11d. pe chaldron of about 1 ton. Allowing for the difference in the valu of money, the price of coal was therefore considerably higher at tha time (the fourteenth century) than it is now.

During the sixteenth century there was a general rise of prices in which coals shared. The price rose from 2s. 6d. a chaldron a Newcastle to 9s. A charter from Queen Elizabeth to the town o Newcastle-on-Tyne in 1600 dealt with the coal trade, and amongs other regulations limited the price of best coals to 10s. a chaldron of second class to 9s., and of "meane coles" to 8s.

During the seventeenth century the price on board ship at Newcastle ran from 10s. to 12s. a chaldron, leaving out of accoun such exceptional prices as that obtained in 1644, when Newcastl was besieged by the Scots, and coal was sold at 80s. a chaldron.†

At the beginning of the eighteenth century we find "The Compleat Collier" (1708) lamenting the low price of coal. "Was it ever heard of or known that this Noble, this Main Coale was sold, as lately it was, or now is, for 8s. per chaldron, Water or Newcastle or Sunderland Measure."

---

* "In the 9th year of King Henry V., A.D. 1421, . . . the burden of keels was limited by statute to 20 chaldrons, 9th King Henry V., c. 10." See Hutchinson's "Durham," p. 607.

"The keel-load long continued to be the principal standard of measure. Thus in 1604, an order of the Privy Council is addressed to the Hoastmen of Newcastle to prevent loading ships by bulk, instead of by 'the juste and trewe measured kele,' and another order in 1613 directs that 'coals are to be sold onlie by the measuredde keles.' It is manifest that the *kele* and the *ten* were at this period synonymous, and that the keel carried ten of those chaldrons, the size of which is afterwards particularly specified in the Act of 30 Car. II., and which constituted the then Newcastle chaldron. It is also clear that the keel-load consists of ten scores of the bolls of that period—twenty-one to a score.

"By statute 30 Car. II., c. 8, the bowl-tub of Newcastle is declared to contain twenty-two gallons and a pottle (22½ gallons) Winchester measure; it was twenty-seven inches in diameter, and there were twenty-one bolls heaped measure to each chaldron. By the same Act the content of each wain is to be seven bolls, and each cart three bolls and one bushel heaped measure, and three wains or six carts are to be a chaldron."—*The Archæology of the Coal Trade*, by T. John Taylor, 1852.

By 6 & 7 Will. III., c. 10 (1700), the Newcastle chaldron was declared to consist of its present weight, 53 cwt. The original chaldron was 2,000 lbs. weight.

† "England's Grievances Discovered," by Ralph Gardiner. 1655.

In 1727 the Durham coalowners entered into an agreement for seven years not to sell for less than 11s. 6d. a chaldron. A recent agreement of a similar nature now in force amongst some North-country coalowners is an instance of how history repeats itself.

Screens were first introduced about 1770, being then made of wood (see C, Fig. 2, Plate II.), and it is not till after that date that we begin to read of "round" and "small" coals. The demand for coal in the London market rapidly increased about this time. This increased demand, and the Continental wars, doubled the price of coal between 1790 and 1815, and the North-country coalowners endeavoured to keep up these high prices by regulating the vend.

Regulation of the vend or "management of the vent," as it is called in an old document) was practised as long ago as 1605, under the control of the Hoastmen of Newcastle, a very ancient fraternity, and early in the present century the matter engaged the attention of Parliament. As the regulation of the vend is sometimes advocated at the present day, the following explanation of how it was done sixty years ago is interesting. It is given in the words of Mr Brandling, a large colliery owner of that day, on his examination by a Select Committee of the House of Commons, as stated in their report, presented 13th July 1830:—

"When it is understood by the coalowners that all parties interested in the coal trade on the Tyne and Wear are willing to enter into an arrangement of this nature, a representative is named for each of the collieries. These representatives meet together, and from amongst them choose a committee of nine for the Tyne and seven for the Wear, which is, I think, the number of collieries on the Wear. This being done, the proprietors of the best coals are called upon to name the price at which they intend to sell their coals for the succeeding twelve months. According to this price the remaining proprietors fix their prices. This being accomplished, each colliery is requested to send in a statement of the different sorts of coal they raise, and the powers of the colliery—that is, the quantity that each particular colliery could raise at full work; and upon these statements the committee, assuming an imaginary basis, fix the relative proportions as to quantity between all the collieries, which proportions are observed, whatever quantity the markets may demand. The committees then meet once a month, and according to the probable demand for the ensuing month, they issue 'so much per 1,000 to the different collieries—that is, if they give me an imaginary basis of 30,000, and my neighbour 20,000, according to the quality of our coal, and our power of raising them in the monthly quantity; if they issue 100 to the 1,000, I raise and sell 3,000 during the month, and my neighbour 2,000; but in fixing the relative quantities, if we take 800,000 chaldrons as the probable demand of the different markets for the year, if the markets should require more, an increased quantity would be given out monthly, so as to raise the annual quantity to meet that demand were it double the original quantity assumed."

The Committee, in their report, observe that "this system, which, by the report made to the House in 1800, appears to have been in operation as early as the year 1771, and which probably existed at an earlier period, has continued in operation with occasional interruptions to the present time."

This compact had a marked effect in keeping up the price of coals in those days, when the northern coal-field almost monopolised the London market. Thus in 1828, with the regulation described above in force, the price for screened coals was 30s. to 36s. 6d. a Newcastle chaldron—say 12s. 6d. a ton—on the Tyne. In 1833, with open trade, the price fell to 18s. a chaldron (=6s. 9d. a ton); but in the following year, the regulation of the vend being reinstated, the price was soon raised to 28s. 6d., and gradually to 30s. 6d.

Mr Matthias Dunn, writing in 1852,* stated that "the regulation of vends was maintained in various states of imperfection, and with numerous discontinuances, until the year 1845. . . . The ruling cause of the permanent dissolution of the regulation arose from the overweening influence of the proprietors of the great collieries."

The increase in the output of coal of the United Kingdom during the present century has been enormous. At the beginning of the century it is estimated to have been about 10,000,000 tons annually; in 1850, 42,000,000 tons (estimated); in 1853, 56,550,000 tons (estimated); in 1854, 64,661,401 tons (accurate figures from this date); in 1864, 92,787,873 tons; in 1874, 125,043,257 tons; in 1884, 160,757,779 tons; in 1894, 188,277,525 tons; and in 1903,† 230,334,469 tons.

From a Parliamentary Return issued in 1886, showing the average price of best coal imported into London since 1820, at the ship's side, exclusive of city or other dues, we gather that the price in 1838 was 23s. a ton. In 1851 it had decreased to 15s. From 1852 to 1885 inclusive, the average price over the thirty-four years was 18s. 9d.—the minimum being 15s. 5d. in 1852, and the maximum 31s. 3d. in 1773. For the decennial period 1855-65 it averaged 17s. 11d.; for 1865-75, 21s. 2d.; for 1875-85, 16s. 10d.; and for 1885-95 the prices in the London market gave an average of 16s. to 17s. a ton.

---

* "Working and Winning of Collieries," M. Dunn.

† The latest figures issued by the Home Office at the time of writing, and are inclusive of 10,174 tons from *quarries*.

According to statistics recently issued by the Commercial Department of the Board of Trade, the average value of coal at the pit's mouth in the United Kingdom was in 1899, 7s. 7d. per ton; in 1900, 10s. 10d. per ton; in 1901, 9s. 4d. per ton; in 1902, 8s. 3d. per ton; and in 1903, 7s. 8d. per ton, since when to the present time the price has continuously and considerably fallen, the rise in prices having commenced in 1897 when the price was 5s. 11d., an increase of 1d. a ton on the previous year 1896, when the average value was only 5s. 10d.

Some useful information in respect of the value of coal is obtainable from the Annual Report issued from the Home Office, making its first appearance in 1894, the issue being due to a recommendation of the Royal Commission on Mining Royalties. This report gives the following figures for 1903

	Quantity		Value	s.	d.	
England,	*160,562,348	tons	£60,844,296	7	6.95	per ton.
Wales,	†34,666,895	„	16,409,362	9	5.6	„
Scotland,	*34,992,240	„	10,922,922	6	2.92	„
Ireland,	102,812	„	48,558	9	5.35	„
	230,324,295		£88,225,138	7	7.93	„

* From *mines* only, the small quantity derived from quarries not being included.

† Monmouthshire is included in England.

INTEREST ON INVESTED CAPITAL.

With regard to the average return upon capital invested in collieries, it is difficult to make any general statement owing to the violent fluctuations in prices which have characterised the trade during the last thirty years. Such evidence as is available is somewhat conflicting, but the average interest per cent. received by the colliery owner has certainly not increased in the same ratio as the increase in wages secured by the working miner.

A statement of profits for the year 1742 of some collieries in the neighbourhood of Newcastle-on-Tyne (known as Byker, Jesmond, Bushblades, Byermoor, and the Lands) shows that 41,482 chaldrons (109,927 tons) of coals had been sold for a total sum of £23,295, making the average selling price 4s. 2.9d. per ton. The expenditure was £18,029, or 3s. 3.3d. per ton, leaving a profit of £5,266, or 11.6d. per ton, a result which many colliery owners of the present day would be glad to realise.

When giving evidence before a Parliamentary Committee in 1830, Mr John Buddle asserted that 5 per cent. was the average profit after returning the capital, and the highest rate he knew was 14 per cent., including redemption of capital. The late Sir George Elliot—in his scheme for a National Coal Trust, made public in September 1893—estimated that an average selling price of 7s. 3d. a ton at the pit-bank would suffice, at the then annual rate of output, to give an interest of 5 per cent. on the debentures which were to form one-third of the capital of the Trust, and from 10 to 15 per cent. on the ordinary stock which was to constitute the remaining two-thirds of the capital. Independently of this, there was to be a sinking fund for the redemption of capital to make the consolidated property permanent.

From evidence given before the Royal Commission on Mining Royalties, Mr T. H. Elliott drew up a report in compliance with the instructions of the President of the Board of Trade, in which he distributed the whole product of the Coal Trade for the year 1889 as follows:—

Wages	55 per cent.	£30,896,250
Royalties	8 ,,	4,494,000
Other charges	25 ,,	14,043,750
Profits	12 ,,	6,741,000
		£56,275,000

He also gave figures supplied by seven colliery companies, showing the trade profits for the year to be £220,922 on an aggregate capital of £2,986,086, or 7.40 per cent.

In the Report of the Labour Commission (1893) it is stated that "in the coal trade of the United Kingdom there is embarked a capital of probably not less than £100,000,000 sterling, and if the average profits on mines assessed to income-tax over the period of ten years ending 1890 were made in coal alone, they would not have paid 6 per cent. on the capital embarked on that industry. . . . Several witnesses informed the Coal Committee of 1873 that the average profits made in the coal trade of this country over a long period of years had not exceeded 2½ or 3 per cent."

Sir James Joicey has estimated the amount of the capital invested in the collieries at £110,000,000, but it is very difficult, if not impossible, to arrive at any satisfactory conclusion in respect of this. Taking his figures, however, as being near the mark, and calculating on the computations stated above as being the correct division of the total receipts, we arrive at a profit return which gives but 4.7 per cent. on the capital invested, and this without allowing anything for the redemption of capital.

Three of the largest coal and iron companies in South Wales, with a total capitalisation of nearly three and three-quarter millions, have paid, over a term of twenty years, average yearly dividends of 1.1, 3.1, and 1.8 per cent.

The late Mr G. P. Bidder, Q.C., in his article on "The profits of Coal Pits," in the *Nineteenth Century* for May 1894, stated (what will hardly be denied) that "an annual return of 10 per cent. on the capital, to include both interest and depreciation or redemption of capital, is surely a very reasonable remuneration. . . . No man would embark his money in colliery property unless he had a fair prospect of obtaining at least this return for it." *

In the year 1903 the Board of Trade issued a return showing the quantity of coal produced in the United Kingdom, its value, the number of coal miners and their average wages for the years 1901 and 1902, with the estimated amounts expended on miners' wages, with the balance for other expenses, and profits of coalowners. Though these figures cannot, for reasons that it is needless to consider in these pages, be taken as strictly accurate for the separate coal mining districts, the probable errors are much smaller for the United Kingdom as a whole. This return shows that for the decennial period 1892-1901 the average output of coal was 198,785,000 tons, valued at £73,052,000 at pits' mouth prices, or an average value of 7s. 4.20d. per ton. The *estimated* number of workpeople employed in coal mining averaging 699,500, the estimated number of tons of coal raised per person employed in coal mining being 284, and the computed average rate of weekly wages 28s. 3d., or, assuming fifty weeks' full employment for each person employed, no allowance being made for disputes affecting employment and production, £49,382,000, leaving a computed amount for expenses other than wages and for coalowners' profits of £23,670,000. Sir James Joicey drew some deductions from the

---

* How the cost of working is increased, and profits are reduced, by restriction of the output, is clearly shown in this article.

Board of Trade figures which had been issued in May 1901, and his letter appeared in the *Times* of 22nd May 1901. He took the costs, other than wages, as amounting to 1s. 6d. per ton, though experts agree that this should be 1s. 9d. at least. It can be shown * that the total receipts may be divided up as follows:—

	s.	d.	
Wages	4	7.01	per ton.
Rents	0	6.50*	„
Materials, &c.	1	1.50	„
Profit	0	6.64	„
	6	9.65	

* Estimated at 5½d. in 1889 by the Royal Commission, but these were below the average for three years over which these figures are taken.

THE FUTURE OF COAL MINING AS AN INVESTMENT AND AN INDUSTRY.

The general tendency in the coal trade, as in most other great industries, seems to be for Labour to receive more and Capital less. "Foreign economic writers are already beginning to remark that one of the most striking of recent economic phenomena in England is the check which appears to have been given to the growth of large fortunes, and the wider and more even distribution of wealth which is taking place." † This phenomenon is unmistakably apparent in the coal trade, of which it may be said—as regards every district in the United Kingdom—that the spoils of the scientific triumphs of the century have gone to Labour rather than to Capital. "In ordinary times" (to quote a high authority, alike in the Coal and the Iron trades‡) "practically the whole of the proceeds of manufacturing operations tend more and more to go into the pocket of the worker, and very often for long-continued periods these proceeds have themselves to be supplemented out of that of the employer, who can only look for anything like an adequate return for his enterprise in those spurts in trade due to some exceptional temporary conditions, which apparently tend to become both fewer and further between in proportion to the development of the resources of the world and the ever-increasing resulting competition. It may be that at one time manufacturing concerns were carried on too exclusively for the benefit of the capitalist. It would almost seem that at the present day the pendulum had swung to the other extreme, and that the programme of some of our advanced social reformers, that capital should be employed and works carried on solely for the benefit of the workers, was practically establishing itself as an accomplished fact."

---

* See "Colliery Manager's Pocket Book" for 1902, *et seq.*

† "Social Evolution," by Benjamin Kidd.

‡ Mr (now Sir) David Dale, in his Presidential Address (1895) to the Iron and Steel Institute.

Besides competition between producers as capitalists, there are influences at work among the manual workers tending in the same direction of advancement in the security of their position. As a recent writer says: "The diffusion of knowledge, the improvement of education, the growth of prudent habits among the masses of the people, and the opportunities which the new methods of business offer for the safe investment of small capitals—all these forces are telling on the side of the poorer classes as a whole relatively to the richer." * It is quite possible, as the outcome of these developments as affecting the production of coal, that future years may see the adoption by the coalowners of this country of some such scheme of collective production as was proposed a year or two ago by the late Sir George Elliot. In the words of Mr Emerson Bainbridge, "The true principle which may, perhaps, some day be evolved out of disaster and misfortune is the principle of co-operation—co-operation which will yield to capital a reasonable return commensurate with the risks and uncertainties of mining, and to the workman as large a proportion of the product of his industry as the condition of trade will afford." †

The chief impression left by an historical review of coal mining in the United Kingdom is the enormous progress made during the last two or three generations in every respect *except* the return made to capital. This is apparent when one reflects that such everyday features of colliery working at the present time as shaft cages and guides, the safety-lamp, the steam locomotive, the trade in coke, ventilating fans, wire ropes, mechanical haulage, mechanical screening, the use of compressed air, and the application of electricity to signalling, lighting, and motive power, have all been introduced in the course of the last hundred years. The progress which has been made may be estimated to some extent by comparing the frontispiece with Plate II. (page 4), showing an average modern colliery and one at the beginning of this century. There is hardly an appliance (save the simplest tools) or a machine in use at a modern colliery which could have been made at the beginning o the century; and even as regards old forms of tools there hav been almost equally noteworthy changes as regards the materia used in their production, as well as in the means of producing them—resulting in greater durability and cheaper cost. From rude and barbarous beginnings, coal mining has risen to the rank of a well-ordered industry, in which many of the latest developments of scientific research and mechanical invention are usefully employed.

---

* "Elements of the Economics of Industry," by Professor Alfred Marshall.

† *Trans. Fed. Inst. of Mining Engineers*, vol. x., p. 429.

CHAPTER III.

CONDITIONS OF LABOUR IN COLLIERIES—PAST AND PRESENT.

Former Conditions of Labour.—Labour plays an exceedingly important part in coal mining, as much as 60 to 70 per cent. of the cost of "getting" the coal being represented by workmen's wages. That "the old men" were skilful and laborious workmen, who proved their capacity in dealing with problems and difficulties unknown in the present conditions of coal mining, is shown by some of their work still to be seen in old mining districts. Many of the old watercourses—upon which, before the era of pumping engines, the existence of most collieries absolutely depended—are monuments of careful toil, being in some cases as much as 12 feet in depth, partly in stone, and partly in coal, and not more than 30 inches in width. Some of them are narrower than this, the width being insufficient to allow a man to turn round, and yet they show straight sides from top to bottom. In the deeper ones, a wooden scaffolding or floor used to be fixed at about half the depth, which served as a half-way stage for removing the stone during the progress of the cutting, and subsequently as a floor for persons walking along the "level."[*] Both in these "water levels," and also in some of the bords driven in the coal, a division for the air current was often provided by cutting in one side of the stone or coal a recess, about a foot square by a foot deep—sometimes called a "grip"—the front of which was covered by a wooden plank, so as to form a separate passage. This was done before the days of bratticing. Water-ways were also sometimes cut in the coal by the side of a place. In some old workings, in a 6-feet seam with a clay band in he middle, one of the authors of this volume has seen a trough formed in the coal above the band and rising at such a level as to allow water filled into it at the face to run away to the back of the place.

It is needless, perhaps, to remark that in the old days labour as cheap, and the hours of labour long. Boys used to work from xteen to eighteen hours a day, so that they literally never saw the un from one week's end to another, and they had an uncommonly ough time of it when they were at work, especially the putters, efore the days of metal rails. This is graphically described in the acy Tyneside vernacular by Thomas Wilson, in some well-known erses :—

THE PITMAN'S PAY.

But heavy puttin's now forgetten,
  Sic as we had i' former days,
Ower holey thill[*] and dyels a' splettin'[†]
  Trams now a' run on metal ways.

This was the wark for trying mettle
  Here ivry tuil his level fand :
Sic tussels nobbut pluck could settle,
  For nowse less could the racket stand.

And had wor bits o' yammerin' yeps
  That wowl about wor barrow-way
To slave and drudge like langsyne cheps,
  They wadn't worsel out a day.

God bliss the man wi' peace and plenty,
  That furst invented metal plates ;[‡]
Draw out his years to five times twenty,
  Then slide him through the heevenly gates.

For if the human frame te spare
  Frae toil and pain ayont conceivin',
Ha'e ought te de wi' gettin' there,
  Aw think he mun gan strite te heeven.

The hewers' hours were shorter, being eight or ten. Within the memory of old pitmen of the present day, it was usual for a man hewing singly in a bord or wall to hew as long as he could get tubs to fill, and then to lay his place full of coals to be filled after his departure by the putter. Sometimes he would be joined at 7 A.M. by his marrow (or partner) of the back shift, and the two would hew together till about 2 P.M., by which time the fore-shift man had usually had enough of it, and went home. In pillar workings, where the coal can be got more easily, they worked shorter hours.

Terms of Hiring.—The custom was to engage men once a year for the whole year, under certain conditions specified in a written document, which was legally binding. The "binding day" used to be an important event. Subjoined is a copy of a Pitman's Yearly Bond, dated 3rd October 1706, for which the authors are ndebted to Mr John Robinson, of Newcastle-on-Tyne. It does not bear signs of legal or literary draughtmanship:—

---

[*] The natural floor of the seam over which the trams were dragged.
[†] Deals split by constant wear.
[‡] Metal plates were introduced underground about 1803.

> "AN AGREEMENT made between Sir Francis Blake of Ford Castle, Knight, and Thomas Wear, William Gardiner, George Williamson, Robert Head, John Ponmant, Alexander Hunter, and James Anderson, all hughers at Gaderick Colliery. Four of the said seven have agreed to work the Stoney Coale, and they are to drive her no wider than ye colliery will beare, and as to the Dip Room, they agree to condy it very strongly as they go on. And it is agreed between all ye said Parties that the said Collyers are to have three bowls out of all they work be they great or small, and ye fourth bowle either great or small, is to be for ye use of the said Sir Francis Blake, and the said Sir Francis is to have his said fourth bowle daily, and is to be put into ye Banksman's hands for Sir Francis' use, and ye said hughers do hereby covenant that they will work five full days in said colliery every week till Easter next, or untill Sir Francis gets on the Main Colliery. And ye said hughers are to pay unto Sir Francis for the use of his Mills three Corfs of small Coles as long as this Agreement continues, and each man to pay one bowle of coals weekly unto Thomas Stuart and ye other three hughers are to work at the Drift until it is finished according to a former agreement. In witness whereof we and each of us, in the penalty of Twenty Pounds every one for ye true performance of said agreement have hereunto set our hands this 3rd day of October 1706.
>
> his
THOMAS X WEAR
mark. — his
WILLIAM X GARDINER
mark. &c. &c.
>
> Witness F. R. BLAKE."

The bowl, which originally was probably a measure containing as much coal as a man could conveniently carry, has come down to the present day in connection with tentale rents. The rents payable to lessors of coal royalties were fixed until recently at so much per ten of coals of so many "bolls," usually 418 or 440 bolls —1 boll=2.23¼ cwt. A rent per ton is now more usual. Three examples of yearly bonds are inserted in the Appendix.

The system of yearly bindings received its death-blow from the great strike of 1844, but it was still carried on in a modified form at some collieries until recently.

At the binding, each man and boy was paid a certain sum. A yearly bond of 1763—engaging 110 hewers and fifty-five drivers at collieries in West Durham, worked by Lady Windsor and Alderman John Simpson—shows that the binding money was 6d. each.

In a letter from John Buddle, addressed to Richard Clayton, Esq., of *Newcastle-on-Tyne, dated 3rd October 1809, informing* him of the conditions of binding agreed upon at a meeting of coal-owners, it is stated that the binding money was to be "for a hewer being a householder, on the Tyne, 5s.; on the Wear, 10s. 6d. For a hewer being a single man, on the Tyne, 8s.; on the Wear, 13s. 6d. Driver on the Tyne, 3s.; on the Wear, 5s. 6d. A tram [there were two putters to each tram], on the Tyne, 16s.; on the Wear, £1. 1s. . . .. The drivers on the Tyne to work fourteen hours to the shift or day's work in single-shift pits, unless the coals can be filled and put out in a shorter time."[*]

The highest binding money ever paid was probably in 1804, when "from twelve to fourteen guineas per man was given upon the Tyne, and eighteen guineas upon the Wear; and progressive exorbitant bounties were paid to putters, drivers, and irregular workmen. Drink was lavished in the utmost profusion, and every sort of extravagance perpetrated."[†] This was due to an extraordinary increase in the demand for coals which had taken place during the year, and to the fear of not being able to procure a sufficient number of men, owing no doubt to the Continental war then prevailing.

At the present time, the term of hiring on which miners are engaged to work at collieries in Durham and Northumberland is from fortnight to fortnight. The terms and conditions usually adopted are such as are set out in the three examples given in the Appendix (pp. 292-300), which are forms of the contract of hiring under which workmen are engaged in collieries now at work.

Former Rates of Wages.—The rate of hewers' wages prevailing at the beginning of the last century is illustrated by the following literal copy of a wage bill (1707) of Gaderick colliery, in Northumberland (already referred to at page 33[‡]):—

GATHERICK, 18*th October* 1707.

All. Hunter, 4 days, Great Cole 1½, Small 38½, Wadges	...	00	02	05½
Jo. Ponmant, 4 days, Great Cole 1½, Small 38½, Wadges	...	00	02	05½
Thomas Weir, 4 days, Great Cole 1, Small 39, Wadges	...	00	02	05
Will. Gordon, 4 days, Great Cole 1, Small 39, Wadges	...	00	02	05
Jas. Anderson, 4 days, Great Cole 1, Small 39, Wadges	...	00	02	05
Robert Hood, 4 days, Great Cole 1, Small 39, Wadges	...	00	02	05
		00	14	07

---

[*] *Transactions of the Derwent Vale Naturalists' Field Club*, vol. ii., p. 22. Paper by Mr James F. Robinson.

[†] Dunn on "The Coal Trade," p. 28.

[‡] For this interesting document the authors are indebted to Mr John Robinson, of Newcastle-on-Tyne.

For putting 240 boles at 5d. per score	00	05	00
For banking	00	04	00
George Wilkinson...	00	04	00
Other Men's Wadges	00	02	00
	00	15	00
For setting a scaffold	00	02	00
	00	17	00

About 1708, it was "most usual to agree with your Hewers of Coals or Miners, by the Score of Corves, by chance for ten pence or twelve pence for each score, according to the tenderness or hardness of the coal, or according to what the Mine will afford, and not by the Day or Shift Work, for it is common to give about twelve pence or fourteen pence for each Shift, when perhaps you will not have above thirteen or fifteen corves a man per shift; so that it is clearly best to agree by the score, and then good Hand, good Hire, as we say, and you pay for no more than you have wrought, or comes out of the Pit." This we learn from that quaint old pamphlet "The Compleat Collier."*

The corf (see B, Fig. 3, Plate III.) was a basket made of young hazel rods, varying in size, holding from 8 to 24 pecks of coal—that is, from 2½ cwt. to 7 cwt., a peck being .30 cwt. The corf was fitted with an iron bow, by which it was attached to the winding rope and drawn up the shaft, and (according to the authority just quoted) was "subject to Clash and Beat against the Shaft sides, and so beats down your Corfe dayly, that if your Corves be not dayly beat up, and mended, you may lose more than one Inch dayly, which would bring your measure or Corfe, of fourteen or fifteen Pecks, down to nine or ten Pecks, and so lose you a third of your measure, and cost of Working or Hewing." The corver, a man who kept the corves in repair, was a regular and important institution before the days of coal tubs.

As to putters' wages at the same period, we learn as follows from "The Compleat Collier": "Besides these Miners, called Hewers, there is another sort of Labourers which are called Barrow-Men or Coal Putters, these Persons take the hewed Coals from the Hewers, as they work them, or as fast as they can, and filling the Corves with these wrought Coals, put or pull away the full Corves of Coals, which are set upon a Sledge of Wood, and so hauled all along the Barrow-way to the Pit Shaft by two or three

---

* London: "Printed for G. Conyers at the Ring in Little-Brittain, 1708."

Persons, one before, and the other behind the Corfe. . . . The Wages for the Barrow-men is usually about twenty pence or two and twenty pence a day for each Tram (that is to say) for putting so many loaden Corves, as are carried on one Sledge, or Tram in one day to the Pit Shaft."

In those early days the hewer did not fill his coals. This was done by the putter or barrow-man, and as recently as thirty to forty years ago it was usual, as already mentioned, for a hewer at the end of his shift to lay his "place" full of coals, and then go home, leaving them for the putter to fill.

From the same source we learn that sinkers' wages at this time were about 12d. or 14d. per day.

In 1752, at a colliery on Cockfield Fell, near Barnard Castle, County Durham, mechanics and masons were getting 1s. 4d. a day, and sinkers, shifters, and labourers 1s. a day.*

A wage bill of Byermoor colliery, in West Durham, for the fortnight ended 28th February 1770, shows that eighteen hewers and eight putters were employed; that the hewers were paid at the rate of 1s. per score of corves (12 peck corf) = 3.3d. per ton; and the putters 9d. per score, or 2½d. a ton. The average earnings of the hewers were 1s. a shift, and of the putters 1s. 8¼d. The pit worked nine days during the fortnight, and drew 162 score 5 corves = 584 tons of coals.

In April 1752 a wage bill for repairs done to a waggon-way from Pontop to Derwent Haugh, a distance of 8½ miles, shows that wrights were paid 1s. 4d. to 1s. 8d. a day, and labourers 10d. a day; and that the price for the hire of a cart and horse was 2s. 6d. a day.*

At the same period, an engineman's wage appears, from the document cited below,† to have been 8s. per week:—

18th October 1760.

AGREED with THOMAS LOGAN to work as Engineman in the New Winning for one year to come from the date hereof, and to be paid for the same Eight Shillings per Week. The said THOMAS LOGAN is to attend the Engine by night or day as occasion offers.

I agree to perform the above agreement. THOMAS LOGAN.

Witnesses—WILL. DOBSON, LUKE CURRY, ALEX. MANCHESTER, JOSEPH WHEATLEY.

---

* *Transactions of the Vale of Derwent Naturalists' Field Club.* Papers by James F. Robinson.

† See "The Delaval Papers," by John Robinson.

A blacksmith got 7s. 6d. a week :—

SEATON SLUICE, *5th March* 1763.

AGREED with GEORGE ALLEN, Blacksmith, for one year, to commence the Twenty-first day of March 1763 at Seven Shillings and Sixpence per week.

From an "Estimate of the Charge of Working Tanfield Moor Colliery, County Durham," dated 9th October 1771 (see page 18)—a colliery which was "won" in 1768—we find that the hewing price in the Hard Coal seam was 5d. a ton; that the putting price averaged 3.12d. per ton; and that the cost of working—including all underground and surface labour, timber, and other materials, and also agency—was 1s. 5d. a ton. The cost of working he Hutton seam at the same colliery, including the same items, was 11.66d. per ton in the whole, and 11.25d. per ton in the pillars; the hewing price in the whole being 2¾d. a ton, and in the broken .94d. per ton.

A pay bill of the Moor Machine pit, Pontop Pike colliery, County Durham, for the fortnight ended 4th December 1786, shows hat the pit worked ten days, and raised 207 scores of corves of coal; hat thirty hewers were employed; and that the average wage per hewer per day was 1s. 9d. Yet these were considered high wages at that time, for William Hutchinson, in his "History of Durham," published in 1787, when writing of the pitmen living in the neighbourhood of Whickham, stated that they "earn great wages, which ecompense every other evil."

The following is a *verbatim et literatim* copy of an old statement of wages, which has been kindly placed in the authors' hands by Mr John Robinson :—

SR and plese your oner, there is the ful of six mens work Each mans 36 Bowls p. day which makes 216 Bowls att 2d p . . is ... £1 16 0

SR and pleas your oner there is the ful Account of all the Expences this Pay

	£	s.	d.
Lise you in for* To six mans Days att 1s. 8d. pr		10	0
Banks Day		1	8
Do. Tuging one Day		2	4
Gin Driveing „ Day		0	8
To three men att the water cours att 18d. p.		4	6
To tow men att the stone Dreft att 1s. 8d. pr		3	4
To Candels used att the tow Drefts		0	3
To Coals over the heap this Pay 56 Bowls at 2 p		9	4
To putting ten score & 16 Bowls att 5½d. pr		4	8
	1	15	9

---

* "Lets you in for"—that is, "There is due from you."

To Mr Robinson belongs the credit of having discovered and brought to light the interesting Delaval Papers. The document here quoted is endorsed on the back in the handwriting of Sir John Hussey Delaval, who was elevated to the peerage in 1786:

In 1740 hewers' wages were from 1s. 6d. to 1s. 10d. a day, and they remained at about this rate up to the last ten years of that century, when there was a great rise in the cost of all labour, owing to the wars in which England was then engaged, and to the consequent demand for men. According to one authority,[*] in 1799 "the wages of pitmen had increased 50 per cent. within ten years;" and in 1813 "wages for hewing had advanced during the last twelve years from 2s. 3d. to 3s. 4d. a day." In other mining districts the increase was apparently much the same as in Northumberland and Durham. Thus in West Cumberland, in 1675, hewers were getting 8½d. a day; in 1709 they were getting 10d. per day, and other workmen as follows:—Trailers (putters), 8d.; brakesmen, 8d.; winders, 8d.; and corvers, 1s. At the same date, the cost of bringing coal to the surface at one of the Whitehaven pits was about 11d. a ton. In 1737 the cost f.o.b. at Whitehaven was 1s. 7¾d. a ton. In 1781 hewing was costing 9d., and trailing 5½d. a ton; and by 1838 it had more than doubled, being 2s. 9d. to 3s. 3d. a ton for hewing and trailing.[†]

In 1826 the Pitmen's Union was founded in the Newcastle-on-Tyne district for the procuring of higher wages, and in 1831 there was a general strike which resulted in "a very considerable advance of wages." This success led to another strike, with the same object in view, in the following year, but the result was that the owners were led to bring men from all parts of the country. In the end a surplus of labour ensued, and a fall alike in prices and in wages occurred.

Wages in 1833 and in 1905.—The ordinary wages paid at collieries in the neighbourhood of the river Tyne in 1833 are given below, with the corresponding wages paid in 1905:—

---

[*] Dunn on "The Coal Trade."

[†] *Trans. N. E. Inst.*, vol. xxxiv., "History of Mining in Cumberland and North Lancashire," by J. D. Kendall; also *Trans. Fed. Inst. M. E.*, vol. vii., "Historical Sketch of the Whitehaven Collieries," by R. W. Moore.

	WAGES IN 1833.	DURHAM 1905 (July).	NORTHUMBERLAND, 1905 (July).	
Fore-Overman	24/ a week with privilege of finding oil and candles for deputies, cranemen, drivers, &c., at 1½d. a day, and 1½d. per score for finding grease for rollers.	About the same as in Northumberland.	54/ a week.	
Back-Overman	..	About the same as in Northumberland.	46/ a week.	
Deputies ..	3/ a day.	4/8½ a shift of 7½ hours, basis rate.*	Whole and backbye, 4/9. Broken and L. wall, 4/3.	Per shift, basis rate.*
Rolleywaymen.	2/10 a day, finding their own candles.	Datal, 10½ hours, 3/5¾ per shift, basis rate; piece, 10½ hours, 4/2 per shift, basis rate.	Long hours,† 3/7. Short hours,† 3/5.	
Hewing ..	2/10 a score; when employed by the shift, 2/10 a shift.	4/2 per shift, basis rate.	Steam coal,‡ short hours, 4/9½. Steam coal, long hours, 5/2. Soft coal, short hours, 4/7½. Soft coal, long hours, 5/.	
Drivers ..	1/2 a day.	1/4 per shift of 10 hours, basis rate.	Same as in Durham.	
Furnacemen	14/ a week, hewing and putting the coal required.	16/6 per week and work 8 hours per shift, basis rate, coal brought to them.	18/10.52 per week, basis rate, coal brought to them.	
Horse-keepers	14/ a week.	16/9 per week, including percentage.	18/10.52 per week, basis rate.	
Shifters ..	2/4 to 2/10 a day.	3/0¾ per shift of 8 hours, basis rate.	3/1 per shift of 8 hours, basis rate.	
Brakesmen	18/ a week.	?	?	
Heapkeeper	2/8 a day.	?	?	
Screeners ..	1/4 to 2/6 a day.	2/10 per shift of 10½ hours, basis rate.	Short hours,† 2/9¾; long hours, 2/11½, basis rate.	

* By "Basis Rate" is meant standard wage, for instance, the percentage of wages above standards at the time of writing (11th July 1905) is, in the various districts, as follows:—Northumberland, 15 per cent.; Durham, 27½ per cent.; Federated Area, 40 per cent.; South Wales and Monmouthshire, 33¾ per cent.; Scotland, 37½ per cent. Therefore, in the case of Northumberland and Durham, 15 and 27½ per cent. must be added to the respective basis wages given above in order to have the current county rate.

† A long hour pit is one that draws coals for eleven hours, a short one for ten hours.

‡ The great bulk of the coal worked in Northumberland is steam coal, which fetches a higher price and is also harder to hew than most of the coal in Durham.

Perhaps 1d. a shift ought to be added to the wages of hewers and putters in 1833, in consideration of the "binding money," which was paid once a year (see page 33).

According to a Parliamentary Blue-Book issued in January 1888, the wages of pitmen in 1834 were 15s. to 20s. a week, with free house and firing.

Proportion of Classes of Underground Labour.—As regards the relative proportion of hewers (actual coal getters) to other classes of underground labour—known as off-hand men and boys—it seems to have been much the same during the last century as at present. From a paper in the authors' possession headed "An

VERBATIM COPY OF AN ACCOUNT OF THE NUMBER OF WORKMEN AT STANLEY AND KIPHILL COLLIERY,

25th October 1769.

---

70 Hewers.
50 Putters (lads).
27 Drivers.

10 Overmen.
6 Gynn Drivers.
6 Banksmen.

16 Wailers.
38 Gynn Horses.
20 Underground.

6 Sledders.
2 Spare Horses.

PRESENT WORKINGS—

				Scores.	Corves.	
Hare Pitt	...	...	...	16	...	per day.
Jenny Pitt	..	...	...	15	...	„
Charlotte Pitt	...	...	...	13	10	„
Hound Pitt	...	...	...	16	10	„
				61	0	

Supposing 3 Pitts to Work—

	Fath.			Hewers.	Lads.	Gynn Horses.	Under-ground Drivers.	Under-ground Horses	Banksmen.	Sled. Horses.	Overmen.	Gynn Drivers.	Wailers.
2*Coggs Double	51	viz., Hare Pitt	18 p. day	19	13	12	10	10	2	2	2	2	4
Foot do.	57	Jenny „	18 „	20	14	12	10	10	2	2	2	2	4
Coggs Single	25	Hound „	25 „	22	32	8	...	...	2	2	2	1	4
		Knab „	...	...	...	4	...	...	...	...	...	...	...
			61 „	61	59	36	20	20	6	6	6	5	12
		Makes to Spare		9	18	2	7	...	...	...	4	1	4
				70	77	38	27	20	6	6	10	6	16

[* **NOTE BY THE AUTHORS.**—"Coggs" refers to the construction of the cog and rung gins used for raising and lowering the corves in the shaft. This gin, in which the winding drum was on the second motion, was a step in advance of the older whim gin, in which the winding drum was on the first motion,—viz., on the vertical shaft rotated by the horses.]

PERSONS EMPLOYED AT, AND DAYS WORKED PER WEEK IN, THE COAL MINES OF THE UNITED KINGDOM* OVER A PERIOD OF FIVE YEARS, 1899-1903 INCLUSIVE.*

(*A.*)—NUMBER OF PERSONS EMPLOYED AT MINES UNDER THE COAL MINES REGULATION ACT (including persons employed in and about Coal, Fireclay, Stratified Ironstone, and Shale Mines).

Year.	United Kingdom. *	Northumberland.	Durham.	Cumberland.	Yorkshire.	Lancashire and Cheshire.	Derbyshire.	Notts and Leicester.	Staffordshire.	Salop, Wor'ster, and Warwick	Glou'ster and Somerset.	North Wales.	South Wales and Mon.	West Scotland.	The Lothians.	Fife.	Ireland.
1899	729,009	37,381	108,060	7,897	102,137	83,440	44,041	31,842	44,958	15,079	12,149	12,008	132,682	68,769	12,317	13,785	993
1900	780,052	39,728	112,835	8,546	107,901	87,976	46,788	34,108	47,788	15,865	13,072	12,629	147,652	73,400	14,133	15,072	997
1901	806,735	41,145	113,934	8,884	111,810	92,791	49,913	35,322	49,475	17,184	13,289	13,377	150,412	75,732	14,776	16,181	933
1902	824,791	41,867	117,017	9,048	114,639	93,387	50,772	37,422	51,438	17,869	13,405	13,342	154,571	75,412	15,131	16,933	778
1903	842,066	42,739	120,716	9,327	117,003	95,306	51,696	38,704	50,739	18,251	13,064	13,248	159,161	76,023	15,710	17,834	761

(*B.*)—NUMBER OF PERSONS EMPLOYED IN AND ABOUT COAL MINES.

Year.	United Kingdom. *	Northumberland.	Durham.	Cumberland.	Yorkshire.	Lancashire and Cheshire.	Derbyshire.	Notts and Leicester.	Staffordshire.	Salop, Wor'ster, and Warwick	Glou'ster and Somerset.	North Wales.	South Wales and Mon.	West Scotland.	The Lothians.	Fife.	Ireland.
1899	715,205	37,381	108,060	7,897	94,959	83,420	43,983	31,743	44,665	14,668	12,183	12,008	132,682	67,013	8,546	13,785	993
1900	766,901	39,728	112,825	8,546	100,826	87,944	46,757	34,621	47,729	15,531	13,072	12,629	147,652	71,984	10,144	15,072	997
1901	792,648	41,145	113,934	8,884	105,283	92,791	49,882	35,232	49,044	16,755	13,289	13,377	150,394	73,193	10,927	16,181	933
1902	810,787	41,860	117,006	9,048	107,755	93,387	50,757	37,332	51,010	17,481	13,405	13,342	154,571	72,916	11,610	16,933	778
1903	828,968	42,720	120,703	9,319	109,863	95,306	51,670	38,610	50,318	17,899	13,064	13,248	159,161	74,445	12,423	17,834	761

(*C.*)—DAYS WORKED PER WEEK BY COAL MINERS (United Kingdom and Principal Districts).

Year.	United Kingdom. *	Northumberland.	Durham.	Cumberland.	Yorkshire.	Lancashire and Cheshire.	Derbyshire.	Notts and Leicester.	Staffordshire.	Salop, Wor'ster, and Warwick	Glou'ster and Somerset.	North Wales.	South Wales and Mon.	West Scotland.	The Lothians.	Fife.	Ireland.
1899	5.46	5.32	5.53	...	5.55	5.43	5.39	4.84	5.39	5.46	...	...	5.75	5.23	...	5.25	...
1900	5.47	5.35	5.53	...	5.57	5.42	5.53	5.04	5.39	5.47	...	...	5.61	5.33	...	5.29	...
1901	5.12	5.20	5.33	...	4.99	4.95	5.04	4.60	4.84	5.18	...	...	5.31	5.14	...	5.05	...
1902	5.22	5.25	5.38	...	5.00	5.02	5.12	4.77	5.07	5.18	...	...	5.64	5.17	...	5.22	...
1903	5.09	5.21	5.35	...	4.95	4.80	4.71	4.39	4.77	4.91	...	...	5.58	5.16	...	5.22	...

---

* This Table has been compiled by the Authors from figures contained in the Tenth Abstract of Labour Statistics of the United Kingdom. (Board of Trade, 1902-1904.)

[To face page 41.

Account of the Number of Workmen at Stanley and Kiphill Colliery, 25th October 1769" (see page 40), we learn that out of a total of 157 employed underground, 70 were hewers, and the output from four pits was 61 score a day. The size of the corf is not stated. By laying off one pit, and getting the same output from three pits, it is estimated that they would save 9 hewers, 18 lads, 7 drivers, and 4 overmen, or 38 hands underground. With the four pits working, the proportion of hewers was therefore 44 per cent. of the total underground hands, and after the proposed change it would be 51 per cent. At the present day, the proportion (according to a Parliamentary Return issued in July 1890) is about 50 per cent. in Northumberland and Durham (see page 98).

Past and Present Wages Compared.—It seems, therefore, that the hewers formed, then as now, roughly about one-half of the number of workmen employed underground, and their wages were at the beginning of the eighteenth century 1s. to 1s. 2d. a shift. One hundred years later they had doubled, being at the beginning of the present century 2s. 3d. to 2s. 6d. for a shift of eight to twelve hours; and now (near the end of the century) they are from 5s. to 6s. for a shift of six to seven hours, whilst, moreover, one pound sterling will now purchase more than it would at any previous period of the century. The privileges of free house and free coals remain the same in the district referred to, the money value of which at the present time can hardly be stated at less than ten guineas a year, or 9d. a working day. Calculating it per hour worked, it may be reckoned that the hewers' money wage, without allowing for the increased purchasing power of money, has been trebled during the present century.

A hewer *working full time*—say 270 shifts in the year (see Table opposite)—will earn £72 at the present (July 1905) average rate of earnings in Co. Durham. Assuming that he has two sons working, a not unusual circumstance, one (say a pony putter) about 17 years old, and another (a driver) aged 14, the former will receive about £45 in the year, and the latter £18, making the yearly income of the family about £135, with a free house and coals. These are average earnings. Under favourable circumstances, a pony putter will put 6 or 7 score of tubs in his shift, and earn as much as an average hewer; and some hewers will make 7s. to 8s. a shift. From the hewers' wages are deducted each fortnightly pay certain sums in payment for benefits received, such as—

Medical attendance	6d. to 9d
Permanent relief fund	8d.
Water supply	6d.*
Fire coal leading	6d.
Pick sharping	3d.
Total ...	2s. 5d.

and also fines for "laid-out" tubs, if he has filled up stone and dirt with the coal.

With regard to most other classes of underground labour, the increase in pay has hardly been so great, but the wages are now on an average at least 50 per cent. higher than they were sixty years ago, and the hours worked daily quite 20 per cent. less.

Increased Purchasing Power of Wages.—A few remarks may here be interpolated as to the increased purchasing power of money, with its consequent effect of enhancing the money value of the wages of the labouring classes, which has taken place during the present century—points upon which all authorities agree. Mr Augustus Sauerbeck, in the instructive papers read by him before the Royal Statistical Society in 1886 and 1893 (vols. xlix. and lvi.), shows that there was a gradual decline in prices of commodities generally, from the early part of the century to the period of the great gold discoveries in California and Australia about the middle of the century. An increase then took place, culminating about the year 1873; and since then the fall has been extraordinary, prices now being on the whole lower than they have been at any previous period of the century. This is due, as pointed out by Mr Sauerbeck, to a variety of causes, the principal of which are (i.) alterations in currencies, the demonetisation of silver, and an insufficient supply of gold relatively to the enormous increase in production; (ii.) cheapening of transport; (iii.) reduction in cost of production, by improved appliances and the development of new sources of supply.

Professor Marshall, in his "Economics of Industry," states that the additions to the real purchasing power of the wages of the working classes in this country have been very great, and constantly increasing, during the present century, owing to the improvement of the means and the arts of transport, aided by the adoption of the policy of free trade in the middle of the century, and the subsequent development of large areas of land in America especially suited for growing grain and meat.

---

* This varies at different collieries, being in some cases 3d. a fortnight, and sometimes no deduction at all is made for water supply.

In modern England (as was recently remarked in the *Newcastle Daily Chronicle*) the "standard of living has been continually rising for a long time; and the average wages of the working classes, owing to the absolute increase of the money remuneration received, and to the great fall in prices, command twice as much of the necessaries of life as did the wages of the working man two generations ago." Or, in other words, as expressed by another writer (Mr P. D. Kenny), "a given amount of wages, as expressed in *£ s. d.*, received by a labourer to-day, can secure to that labourer at least 25 per cent. more of decency, comfort, or anything else, than it would have done thirty years ago." In a paper by Mr A. L. Bowley, on "Changes in Average Wages (Nominal and Real) in the United Kingdom between 1860 and 1891," recently read before the Royal Statistical Society, the general conclusion was reached, that allowing for the increased purchasing power of money, the average wages in the chief industries of the country have *doubled* since 1860.

The increase in the purchasing power of gold during the last thirty years is well shown by the alteration in its value in exchange with such common commodities as English wheat and iron. 123.27 grains of standard gold would exchange for 171 lbs. of English wheat at the average price during the period 1867-77, and for 394 lbs. in 1893. While, taking iron, 123.27 grains of gold would exchange for 272 lbs. of iron at the average price during the period 1867-77, and for 448 lbs. in 1893.*

These remarkable changes in value were referred to by Sir David Dale in his recent address (1895) as President of the Iron and Steel Institute, when he said that "for every sovereign expended, the world can now get more than four times the length of rails, and more than twice the quantity of wheat, that it could a little over twenty years ago."

Present Conditions of Labour in Collieries.—The bulk of the labour employed in coal mines is now better remunerated than that employed in most other great industries, and although much of the work is hard, it is not usually unhealthy or unpleasant to strong men. By the aid of science and engineering skill conditions naturally adverse and dangerous have been much ameliorated, and these improvements and safeguards are enforced by stringent legislation.

---

* These figures are taken from a Table constructed by Mr J. W. Miller and published in the *Manchester Guardian* of 10th July 1894. They were quoted by Professor J. Shield Nicholson in an article on "The Influence of the Production of the Precious Metals on Industry and Trade," which appeared in the *Co-operative Wholesale Societies Annual* for 1895.

As a class, the mining population are inclined to err on the side of extravagance rather than of parsimony, but in most colliery villages there are at least a few men who have saved money, and invested it in house property, or with a local co-operative society, or in some cases in shares in joint-stock companies. The local co-operative stores in such villages have undoubtedly done much to encourage and promote thrift; the buildings in which their operations are carried on are frequently the most prominent architectural feature of the neighbourhood; and they are under the control of the miners themselves.

It is not easy to obtain reliable figures, showing the actual expenditure of an average family employed in coal mining. According to a Report of the Commissioners of Labour of the United States, 1890, the expenditure for a year of a coal miner in Great Britain on all objects—food, clothing, house, furniture, recreation, &c., with a family consisting (besides himself) of a wife and three children ranging in age from three to nine years—amounts to £87. 5s. 11d., as compared with an income of £99. 14s. 4d., leaving him a surplus of £12. 8s. 5d. The details given by the Commissioners appear in the following abstract from the *Journal of the Royal Statistical Society*, vol. lvi. (Paper on "Workmen's Budgets," by Henry Higgs):—

INCOME AND EXPENDITURE FOR A YEAR OF A COAL MINER IN GREAT BRITAIN.—BITUMINOUS COAL.

(*Extracted from Sixth Report of the Commissioners of Labour of the United States*, 1890.)

Husband, 33; wife, 33; first child, boy, 9; second, girl, 5; third, boy, 3—Total, 5. Income, husband, $478.64 = £99. 14s. 4d.

Expenditure for food—

Hog products		$25.30
Meat		75.92
Eggs		12.65
Lard	26 lbs.	3.16
Butter	78 "	18.98
Tea	26 "	12.65
Sugar	104 "	4.22
Molasses		1.58

Potatoes	$8.11
Milk	16.87
Flour and meal	39 42
Rice	1.22
Vegetables	2.43
Food not specified	41.86
	$264.37 = £55 1 6

Expenditure other than for food—

Rent (3 rooms)	$40.06
Fuel (coal)	12.16
Lighting (oil)	4.38
Clothing husband	14.60
„ wife	12.16
„ children	9.73
Furniture and utensils	2.43
Insurance life	8.44
Organisations—labour	6.33
„ other	6.33
Charity	1.46
Books and newpapers	1.46
Amusements	2.43
Intoxicating liquors	18.98
Tobacco	12.65
Sickness and death	1.05
Total for year	$154.65

Expenditure for—

Rent		$40.06
Food		264.37
All other purposes		114.59
	= £87 5 11	$419.02
Income	99 14 4	478.64
Surplus	£12 8 5	$59.62

Dollar = 4s. 2d.

In pit villages in the Northumberland and Durham district, he expenditure at co-operative stores, where most of the supplies f food and clothing are bought, runs from 18s. to 24s. per family er week. Unmarried hewers in the county of Durham, where nly married hewers are entitled to free houses, pay from 12s. to 5s. a week for board and lodging.

In 1852-53, when the cost of living was higher than it is now, a an, still living, was occupying the position of back-overman at a age of 22s. a week, with free house and firing. His eldest son as working as a "wailer" (picking stones out from coals), and was earning 5s. 9d. a fortnight = 2s. 10½d. a week. The receipts, amounting to £1. 4s. 10d. a week, represented the entire income of the family; and upon this the man supported a wife, six children, and himself—eight souls—without getting into debt. Much, no doubt, depends upon the wife.

To take another instance of a man who has worked as a blacksmith for over fifty years at a Durham colliery. Shortly after his marriage in 1845 (he celebrated his golden wedding in 1895), he and his wife determined to lay by a certain sum every pay. This they have done regularly ever since, the sum saved amounting to £1 a fortnight on the average. They now possess capital to the extent of nearly £2,000, and they have brought up nine children, all of whom are doing well. For many years the wife used to take the money every month to a savings bank in the neighbouring town, walking a distance of about seven miles on each occasion.

It cannot be denied that, in too many cases, a large portion of the wages is spent at the public-house, and in sports and gambling. A popular public-house in an average colliery district will take from £50 to £100 over the "pay week end." The authors do not wish, however, to convey the impression that most miners are drunkards or gamblers, for this is not the case. As in all large classes of men, the individuals differ much in character, tastes, and disposition—from the man who reads and takes an intelligent and active interest in all that tends towards social and intellectual development, to the man whose main idea of enjoyment is a "good boose" in a public-house, or who finds his chief recreation in risking his money on some sporting event.

As regards house accommodation, miners, on the whole, are well housed, although there are a good many exceptions to this rule, especially in the older districts, where the houses were built many years ago. The new District and Parish Councils are already exercising a beneficial influence in this direction. The provision made for individuals may be learnt from statistics gathered in a large colliery district, from which it appears that 5,291 persons are living in 946 houses belonging to colliery owners. This gives an average of 5.59 persons living in each house. About 32 per cent. of the total number are working at the collieries, so that the proportion of workers per house is barely two. 44 per cent. of the houses contain two rooms, 30 per cent. three rooms, and 26 per cent. four or more rooms.

Benefit and provident societies, such as the Ancient Order of Foresters, and the Independent Order of Oddfellows, are well supported by the miners, and there are also local societies of a similar character, such as the Northumberland and Durham Miners' Permanent Relief Fund, an excellent institution, with a membership of about 121,000, and a total annual income of over £100,000. The payment of a miner to this fund is at present 8d. a fortnight for a full member. The Trades Unions also make their claim on the miner's earnings of about 6d. to 10d. a fortnight. Notwithstanding the unthrifty habits of many miners, and the demands on the earnings of the class from the quarters just indicated, money is saved by an appreciable number.

One thousand pounds during the year is not an unusual amount to be deposited in a Post-Office Savings Bank in a colliery district, comprising some six hundred or seven hundred families living by mining.

The coal miner, with his very capable representatives in Parliament and elsewhere—men who have themselves risen from the ranks of working miners—is an important factor in that evolution of democracy, and new adjustment of industrial and social conditions, which is perhaps the most prominent feature of our day. The great change for the better in nearly all the conditions of life amongst working miners—which has been secured, partly by their own exertions, but in greater measure as a result of the general raising of the standard of obligation to the manual worker—and which presents a striking contrast, not only to the state of things prevailing say a century ago, but to what prevailed within a period covering the working life of many miners now at work, will have been largely illustrated in the particulars given in this chapter.

CHAPTER IV.

THE PRACTICAL MANAGEMENT OF A COLLIERY.

WHAT manner of man ought a colliery manager to be? It is n easy to answer this question in the form of a neat definition. an admirable address given by the late Sir George Elliot President of the North of England Mining Institute in 1868, said: "I have seen it asked, What is it to be a gentleman? Is it be honest, to be gentle, to be generous, to be brave, to be wise, & &c.? In some such spirit would I like the question to be aske What is it to be a mining engineer? Is it to become reverent acquainted with the secrets of nature? Is it to show courag wisdom, and tact in dealing with grave scientific problems, and the discharge of the delicate duties pertaining to all called upon be leaders of men? . . . Let us then, gentlemen, in estimati our profession, and in seeking to gauge its future, be true to ea other and ourselves. . . . Believe me, the knowledge and skill the physician, the chivalrous bravery of the soldier, the gent charity of the priest, the far-seeing toleration of the philosophe might all find an ample field for their display in the regular duti and professional emergencies of our career. No vocation can more useful, more worthy, or more honourable; there is none whic we could follow with more advantage to others, or with great moral or material benefit to ourselves. The teaching of our pr fession is as varied as it is endless, and the wisest and best amon us has but to strive humbly for wisdom to comprehend, an strength to improve upon, the lessons of his daily life, to becom not merely a more skilful miner, but a more useful citizen, and more worthy man."

Another President of the same Institute, the late Mr Edwar Fenwick Boyd, in his presidential address in 1869, referring to th wide range of information useful to the mining engineer, and th necessity of constant advance in knowledge, said that "the exper ence of fifty years of a mining engineer's life would lead him . .

to impress upon his hearers the idea that in his profession there was scarcely a subject of interest to the well-informed and patiently adjusted mind, with which the mining engineer ought not to have acquainted himself — from the evaporation of fluids to the combination of mechanical forces; from the sanitary necessities of drainage and water supply to the delicate construction of the coffin-bone of the foot of the horse; from the building of a boiler to the barometrical pressure of the atmosphere; from the deposition of dew to the insinuating influences of a galvanic battery; from the forging of an engine-axle to the proper interpretation of a legal mining document."

To quote a living authority—one who is equally qualified by ong and varied experience to express an opinion—Mr. T. Forster Brown, when speaking at the annual dinner of the National Association of Colliery Managers in September 1894, said: "The colliery managers of to-day had to grapple with very different things from what they had to grapple with forty years ago. They had to work the coal from great depths; they had to labour under stringent egislative enactments, imposing very serious personal responsibilities. A successful colliery manager of the present day needs to be a first-rate organiser, not only as regards labour, but in other ways, and in fact is an entirely different person from his predecessor thirty or forty years ago. The ideal colliery manager ought to be a scientific philosopher, with a thoroughly practical knowledge of mining, of men, and of applied mechanics; he ought to have great irmness of purpose, great perseverance, and (he thought he might add) a good digestion."

These three quotations from men thoroughly qualified by extensive experience to speak on the subject, are sufficient to bring home the fact that the position of a colliery manager is no inecure.

The "useful performance" of a colliery, in its strictly material aspect, can hardly be better defined than by the expression already quoted in the Preface, "The getting of the largest possible proportion of the available coal in the best possible condition [that is, in such a condition as to realise the highest value in money] at the lowest cost, and with the greatest safety and comfort to those employed." This implies that the coal shall be worked by the particular method or methods best adapted to the special circumstances and conditions of the particular colliery and the seams worked thereat; that the coal when got shall be conveyed to the surface in the most economical and speedy way; that on the surface it shall be so treated and separated into the different qualities required, that without loss of time it is placed in waggons in such a condition as to satisfy the needs of the several classes of purchasers, and command the best market price. It implies, also, that all the machinery and appliances in connection with the colliery are those best adapted to its requirements; that the materials are the most suitable, and are bought in the cheapest market; that the labour is arranged and directed in the most efficient way; that the workmen, and all officials acting under the direction of the manager, do their work with goodwill and efficiency; that every available precaution is taken against accidents; that there is no extravagance or waste, whether of time, labour, or materials, in any department. It implies, moreover, that the colliery is conducted and managed on a consecutive and long-sighted policy, with a view to its future as well as to its present development. A large quantity of coal may sometimes be easily got, at a low working cost, for a brief period, but this in such a manner that this apparently satisfactory result may have a disastrous effect on the prosperity of the colliery viewed as a whole.

What knowledge, then, and what personal qualities are desirable in the colliery manager? The reply to such a question may be conveniently considered under three heads:—(1) He should be a well-trained mining engineer; (2) he should be a good man of business; (3) he should understand human nature, and be capable of dealing effectively with men of varying characteristics and qualifications.

Dealing with the first of these requirements, that he should be a *well-trained mining engineer*, the provisions of the Mines Regulation Act now ensure that a colliery manager shall have had a fairly good preliminary training. The qualifications to be actually demanded are by the Act left to a large extent to the decision of the Boards of Examiners appointed in each mining district, and these qualifications, as regards age and experience, vary somewhat at the present time in the different districts, though there does not seem to be any good reason why they should. Taking the Newcastle district as fairly typical, the qualifications of candidates for certificates as managers of mines are as follows:—

"The candidate must be twenty-two years of age or upwards. Must have had actual practical experience for at least five years as under-viewer, assistant-viewer, fore-overman, or back-overman; but at least two years' experience in any of these capacities will be deemed sufficient in the case of a candidate who during such two years has held a second-class certificate.[*]

"Two years' or three years' apprenticeship to a mining engineer, with evidence that such period afforded substantially practical experience in a mine, shall be regarded as a substitute for an equivalent period of such employment.

"*Subjects for Examination.*—Ordinary education—reading, writing, and arithmetic.

"Engineering—General principles, including pumping, &c.

"Practical Mining—Mode of sinking, working, timbering, bratticing and ventilation; the nature and property of gases; to know the duties of a manager as described in the Mines Act."

The necessity of a good scientific training is yearly becoming more important. In the words of Mr Emerson Bainbridge,[†] "One finds, as step by step the various phases of the engineering of mines are examined and studied, that an extensive acquaintance with the sciences of geology, chemistry, mineralogy, metallurgy, meteorology, and the whole of the wide field of research comprised by the term 'mechanics,' is essentially necessary in order to enable the mining engineer to deal with the many and various questions and difficulties which will arise in the course of his experience." The progress of both scientific discovery and industrial invention, as applied to mining matters, is very rapid, and is likely to become more so, owing to extended opportunities for observation and experiment, the spread and improvement of technical education, and the increasing keenness of competition in every walk of life. It is only necessary to glance over the last ten years to realise this. During that period valuable additions have been made to our knowledge of the dangerous properties of coal-dust, of the safest explosives, of the use of electricity for lighting, signalling, and for the transmission of power. Great improvements have been made in safety-lamps, in ventilating fans, in pumping machinery, in appliances for preventing overwinding, in the banking, screening, and cleaning of coals, and in almost every department of mine engineering. The opinion, on any of these points, of a colliery manager who should be content with the knowledge available ten years ago, or even five years ago, would be worth very little to-day. To keep himself abreast of the latest knowledge, and of the best appliances and inventions bearing on his work, a manager must always be something of a student. Not only must he devote some time to reading, but to visiting places where the latest improvements may be seen in operation.

---

[*] By the Coal Mines Act, 1887, it was enacted, section 23: "There shall be two descriptions of certificates of competency under this Act—(1) First-class certificates, that is to say, certificates of fitness to be manager; and (2) second-class certificates, that is to say, certificates of fitness to be under-manager; but no person shall be entitled to a certificate under this Act unless he shall have had practical experience in a mine for at least five years."

[†] "On the Education of Mining Engineers," *Brit. Soc. Min. Stud.*, vol.

He should know what is the best appliance he can get, or the best course he can pursue, when the necessity for action or decision arises. And this requires not only an acquaintance with machinery and appliances, but a sound judgment as to their suitability to special circumstances. The probable cost of working and attendance, and the cost of maintenance and repairs, are usually much more important factors than the first cost. There can be no doubt of the practical benefit to the colliery proprietor of wide knowledge and sound judgment on the part of the manager. Hundreds of pounds a year may be saved, for instance, by an improved type of engine or boiler. At most collieries there is available a wide margin for economy in the consumption of fuel. The best type of engine now consumes under 2 lbs. of coal per indicated H.P. per hour, but the average consumption of colliery engines is probably three or four times this amount.

In the second place, the colliery manager should be *a good man of business*. A colliery is an extensive and valuable property, in connection with which there is a good deal of business to be transacted, altogether apart from mining and engineering. This is especially the case in districts like Durham and Northumberland, where the miners' houses and often much of the adjoining property belong to the owner of the colliery. There are business relationships with district and parish councils, assessment committees, sanitary authorities, school boards, water companies, railway companies, and such like; a large and varied supply of materials is required, the selection and purchase of which involve negotiation with competing manufacturers and dealers; legal questions will often crop up; farmers and other owners or occupiers of property in the neighbourhood will be claiming compensation for damage caused by underground workings, or other operations incidental to the conduct of the colliery. There are letters to be written; wage bills, cost sheets, and account books have to be examined; while much of the daily routine work of a colliery manager is such ordinary business as is common to the control of all large concerns.

and has nothing to do with mining or engineering. He should therefore be a good man of business—that is to say, a man who transacts his business with regularity and despatch, who is clear-headed and has a good memory, and is punctual and methodical in his habits.*

In the third place, the colliery manager should *understand human nature, and be capable of dealing effectively with men.* Probably the most harassing and unpleasant part of the work of many colliery managers is managing the men, and avoiding or settling disputes with them. The position of mine managers in relation to working miners has entirely changed within the last thirty or forty years. In former times a manager was practically an autocrat: he could at once dismiss any man who made difficulties, but during the last thirty years the social progress of the manual labourer has been advancing with accumulating velocity, and in particular the miner of the present day has very different ideas and feelings from those of his predecessors one or two generations back. He has much more time to himself, he goes further afield, and mixes more with other people, on the occasion of a great exhibition he may go so far as Paris or the United States. If a thrifty man, he has money accumulating in his local co-operative society; if young, he has received an elementary school education, which must undoubtedly affect his character, even though he may forget most of what he has learnt. Again, the betterment of labour is in the air; various agencies are at work for his improvement; and last, but not least, he has his powerful Union, and for his representatives in Parliament men who have themselves worked in the mine, and through the Union have reached the House of Commons as members for constituencies in which miners abound. What wonder, if in his new-found liberty the miner is filled with a sense of his own importance, and at times is inclined to be headstrong?

---

* As a concise statement of what is required nowadays from the manager of a colliery, the authors may quote also the subjoined passage from another work:—"Even a slight acquaintance with the duties and responsibilities of a Colliery Manager will lead to the conclusion that he had need be almost omniscient within his own province. Besides his responsibility for satisfactory results in the opening-out and working of a colliery, under the ever-varying conditions of coal-mining enterprise, there rests upon him a heavy legal as well as moral responsibility which no true man would wish to shirk, and in the discharge of which he has to prepare for that which happens more often, perhaps, in his career than in that of most professional men—viz., *the unexpected.* It becomes him, therefore, to fit himself beforehand in every possible way for the discharge of his onerous duties. In so doing he will have to acquire the rudiments of Geology, Chemistry, and Electrical Engineering; a good deal more than the rudiments of Mechanical Engineering, Surveying, and Plan-making; and to make himself master of the mysteries comprised in the comprehensive terms Practical Mining and Ventilation. Further, he must be thoroughly versed in the obligations imposed upon him and his subordinates by the Acts of Parliament bearing on the subject of Coal Mining, and by the Special Rules in force in any given district."—From Preface to *The Colliery Manager's Handbook*, by Caleb Pamely, M.E. London: Crosby Lockwood & Son.

It is quite evident that the miner of the present day cannot be treated in the old arbitrary, high-handed manner. Sympathy, firmness, self-control, and tact are the qualities most required in dealing with men effectively. Without real sympathy a manager will never get on well with his men. In order to influence them, or to lead them to change their point of view, he must realise their state of mind, see with their eyes as it were, and stand in their shoes. In all negotiations he should have a clear conception, in the first place, of what he wants, and in the second place of how they will regard it; and then he should proceed in such a way as to avoid needlessly exciting prejudice or ill feeling. Here he will find ample scope for the exercise of firmness, self-control, and tact, that intuitive perception of the right thing to do, and how to do it.

It is probably a mistake to take every opportunity of cutting down wages to the lowest possible point. Such a policy creates a feeling of irritation, which is likely to be more detrimental to the interests of the colliery owner than if he had continued to pay a little more in wages. If men think that a manager will take every advantage of them that he can get, they will naturally look upon him with suspicion. On the other hand, if men are convinced that he will treat every question that comes before him fairly and honestly, without fear or favour, it is a great step gained.

Two Presidents of the National Association of Colliery Managers have referred to this matter of treatment of men, and their words are worth repeating here. The late Mr Rogers, of Wigan, said: "I would impress upon you the fact that colliery managers are men of position, who should respect their office and themselves if they desire to have their office and themselves respected by others. They should be courteous in manner to those under them, while firm in their determination to see that all do their duty. Violence, hasty temper, and bad language only degrade, and do not assist the manager in controlling those under him; whereas a kindly word, and an interest, so far as is practicable, in each collier's work, is a surer method of having the manager's orders obeyed." Mr Henry Palmer, one of the mining agents of the Consett Coal

Company, also gave wise advice when he said: "The object of every manager of mines should be to retain the management of his own workmen in his hands, and to trust as little as may be to the extraneous aid of joint boards or of other constitutions. By so doing I am convinced that harmony and goodwill can almost invariably be ensured between the manager and his men, especially if the golden rule be followed—viz., if a grievance exist, remove it. If a grievance which is non-existent is put forward by the workmen, it is quite within the bounds of possibility to prove that no such grievance as alleged exists, and to restore that harmony which should always prevail."

Miners, it must be remembered, are not machines existing merely for the sake of doing work at the colliery. Like most other men, they are governed by feelings, by prejudices, by habit, much more than by reason, and they are more easily led than driven. It is unavoidable that a manager should often have to refuse what the men want, and to enforce what they dislike. It is well, therefore, that he should cultivate pleasant relationships with them. This he may do by taking a personal interest in their reading-rooms and institutes, their athletic clubs, their musical bands, or in some of the various institutions which usually exist in colliery villages—in short, by taking advantage of opportunities for personal contact with them under circumstances favourable to friendliness and goodwill.

In considering in detail the duties of a colliery manager, the importance of dealing properly with various sorts of men is most apparent. He is every day conferring with his under-officials. These men will insensibly take their tone to a large extent from him. If he takes an active interest in his work, shows a conscientious sense of duty, and is honourable and upright in his dealings, they are likely to be the same; and the opposite is no less true. In the words of an eminent authority, "it should never be forgotten that the example and precepts of those in charge of our pits exercise an enormous influence for good or evil. Show me a community of miners, and I will tell you the character of their chief; let me see *their* daily habits, and I shall form my estimate of *his*." In the ordinary course of his business, too, as already pointed out, the mine manager has to deal with a variety of men not immediately connected with the colliery, and the importance of tact, and the weight which will be attached to character, in one's dealings with those outsiders, as with one's colleagues and workmen, can hardly be overrated.

The consideration of the duties of a manager will be very incomplete without some reference to the provisions of the Coal Mines Regulation Acts. The first Act of Parliament which materially affected the position of a manager, and added to his work and responsibilities, was passed in 1872, and was succeeded by a short amending Act in 1886. These two enactments were superseded in 1887 by the Act (50 & 51 Vict., c. 58) at present in force, which is expressed (s. 3) to apply to "mines of coal, mines of stratified ironstone, mines of shale, and mines of fireclay."

The Act of 1887 provides (s. 20) that every mine* shall be under a manager holding a first-class certificate under the Act, and requires the owner or agent of every mine to nominate either himself or some other person to be manager, and to send written notice of the manager's name and address to the inspector of the district. Responsibility for every working colliery is thus fixed on an individual manager, and the Act further requires that a code of General Rules there set out (s. 49) shall be "observed, as far as is reasonably practicable, in every mine," in addition to the Special Rules which, as also provided by the Act (s. 51), are to be established in every mine. The Official Abstract of the Act, with the Special Rules in force in Northumberland and Durham, are given in the Appendix to this volume.

The duties of the manager of a colliery are defined as follows in the Special Rules in force in the counties of Durham and Northumberland:—

"He shall be responsible for the control, management, and direction of the mine, and shall himself, or by an under-manager where appointed, exercise daily personal supervision of the mine; and shall comply with the requirements, and to the best of his power enforce the observance of the Act and of the Special Rules, and shall appoint such competent persons as may be necessary for carrying out the provisions of the Act.

"He shall give attention to any complaint, and inspect, or cause to be inspected, such parts of the mine as may be reported to him unsafe, and to need attention; and shall receive and examine the official reports (or copies thereof) required by the Act and Special Rules.

"He shall see that printed notices are hung up in proper places, and renewed when obliterated, relating to the codes of signals to be used in the shafts and on incline and engine planes, and the number of persons to descend and ascend in a cage at one time. He shall appoint the station or stations required by General Rule 4,* and by the Special Rules, and indicate their position in the mine by printed or painted notices in large type; and he shall keep or cause to be kept, at the office at the mine, the registers of boys, girls, and women, as required by the Act."

---

* [illegible] mine in which not more than thirty persons are employed below ground is exempted (by the Act) from the provisions of this section, unless the inspector of the district shall require that it be under the control of a manager.

Personal supervision and control is the burden of this summary of the duties imposed by law on the manager of a colliery. Frequent inspection of the whole colliery, both on the surface and below ground, and accurate knowledge of all that is being done, is an essential part of a manager's duty. He needs to cultivate the habit of exact and critical observation, and of good memory. He should be quick to notice defects, remembering that "a stitch in time saves nine," and that a pound or two spent in remedying some small defect at once may save a much larger expenditure subsequently. He should bear in mind that in the management of a colliery there is always scope for improvement. At every colliery there is a tendency to waste—waste of labour by the idleness of workmen, or perhaps by setting too many men to one piece of work (and it should always be remembered that the wages of labour constitute about 60 per cent. of the total expenditure at collieries); waste of power, by unnecessary weight of machinery or appliances, or by not utilising surplus energy; waste of material, by carelessness and extravagance, or by throwing away old stuff which might be usefully employed. To check this tendency to waste, constant supervision is needed.

The very objectionable feature of the Mines Act at present in force is that, in the words of the late Mr Maskell Peace, an eminent lawyer, it casts upon the manager, "under various circumstances, a primary responsibility (which he can only rebut upon proof) should any person whomsoever contravene or fail to comply with, or permit any other person to contravene or fail to comply with its numerous stringent provisions." Of all the important industries, mining has to contend with the greatest natural difficulties and dangers. A large number of workmen are required, who are not always the most intelligent and careful of men, and by the default of any one of these, an accident may happen. Even under the most skilled management, and where every precaution is taken, accidents do occur. Not only is it a manager's duty, but it is his interest in every way to avoid accidents. That after using his best endeavours, he should be assumed to be guilty, and should be called upon to prove his innocence, of faults committed by other persons, whose actions it is impossible that he can always control, is certainly harsh, if not unjust, legislation. Whether it is in accordance with the ordinary spirit of English law is a question for a lawyer rather than for a mining engineer.

---

* See Appendix II.

The Check-Viewer.—Before closing this chapter, some reference to the relations to the working of a colliery of the official known as the Check-viewer may not be out of place. The check-viewer acts for the owner of the coal—that is, for the lessor—and his duties are to arrange the terms of the lease; to obtain accurate accounts of the coal worked from the property, as well as of coal from adjoining properties which may be brought through it,—the lessor's property,—and which is therefore chargeable with outstroke* or wayleave rent; to render accounts for the payment of the rents when due; to see that all the coal is got so far as possible; and generally to look after the interests of the lessor, and to see that the covenants in the lease are fulfilled by the lessees.

The usual lessees' covenants are to pay the specified rents when due; to pay all rates and taxes, except landlords' property-tax or income-tax; to work the coal in the most approved method, and to the satisfaction of the lessor or his agent; to keep account of all coal worked, and to give a copy yearly to the lessor or his agent; to permit the lessor or his agent to examine the books of accounts and the plans, and to make copies, to inspect the mine, and make surveys at all seasonable times, and to render them every facility in so doing; to pay compensation for all damage done to the surface, to houses, or other buildings, to plantations, crops, &c.; to keep the lessors harmless from all actions at law in connection with the lease; not to assign or sub-let without license; to yield up peaceable possession at the end of the lease; to level and restore to a ploughable state, and fit for agricultural purposes, all land used, or to pay compensation not to exceed the value in fee simple. Disputes on any of these points to be settled by arbitration.

---

* The quantity of coal worked from each royalty per fortnight is stated on the Overman's Wage Bill, and is copied from it into a Royalty Book, kept for this purpose.

The lessor usually reserves to himself power of distraint if rents are not paid within twenty-one days, and power of re-entry and ejectment if rents are not paid within forty days, or if there is a breach of the covenant against alienation without license.

The lessee usually has power to surrender the lease at certain periods, such as any third year of the term, on giving twelve months' notice in writing.

As to the rents, a fixed or certain rent is agreed upon, estimated on the area of the royalty leased, say 20s. or 30s. an acre, which is payable half-yearly, whatever may be the quantity of coal worked. A price per ton is also settled (6d. a ton is an average rent), and when in any year the number of tons worked at this rent exceeds in value the certain rent, the surplus is paid as "overworkings"; but when it falls short, the deficiency is carried forward as "short workings," to the next year's account. The lessee has power to make up "shorts"—that is, to set them against subsequent "overs," in some leases during the whole period of the term, in others during septennial periods only, or sometimes during periods of three years; but whatever the period, if he fail to work enough coal to liquidate the fixed rents which he has paid, he loses the difference at the end of the period. The tendency of this practice is towards over production, as it leads a colliery proprietor to keep up his output of coal, even when he is making little or no profit on it. He may be working at a loss, and yet to reduce his output may cause him greater loss.

The variation of the tonnage rent in proportion to the average selling price of coal at the pit's mouth is an arrangement between lessor and lessee which has been advancing in favour within recent years. This arrangement is facilitated by the practice, which is now customary in many mining districts, of the Owners' Association to obtain the average selling price throughout the district each quarter of a year. For this purpose all the colliery firms in the Association make returns, giving the quantity of coal sold, the money received, &c., which are examined by accountants, who certify the average selling price. The immediate object of this system of periodical returns is to supply data for the settlement of the rate of wages to be paid to workmen in the district. If lessors and lessees agree to accept the selling price thus obtained for the purpose of a sliding scale on which to settle royalty rents, further investigation into the books of a particular colliery is avoided. In Northumberland and Durham, an average ratio between the selling price at the pit's mouth of all coals sold and the royalty rent is

12 to 1—that is, if the selling price is 6s., the rent paid to the lessor will be 6d. a ton; but most sliding scales will allow the lessor a larger proportion as the selling price rises above 6s., and a smaller proportion as it falls, and this appears to be an equitable and satisfactory arrangement for both parties.

In Yorkshire and the Midland District, the lessor is paid on the area of coal worked—so much per acre of a given seam, or sometimes per foot-acre, that is per acre per foot thick of coal. Every six months careful underground surveys are made on behalf of the lessor, and these are verified by comparison with the surveys made by the colliery officials. The area is then computed from the plan, which can be accurately and readily done, when the coal has been worked by longwall, as is usually the case in these districts. With other systems of working, it is much more troublesome to arrive at the exact area worked during a given period. The price per acre is sometimes arranged on a sliding scale with the selling price of the coal. This system of payment by area gives the check-viewer more work than when the payment is on the ton brought to the surface, and he usually employs a staff of surveyors. One advantage of the system is that deductions on account of poor or worthless coal can be readily settled.

The subject of royalty rents has given rise to much discussion from time to time. It has been contended that the rents paid in this country tend to keep down wages, and also to handicap our coal trade in competition with that of foreign countries. A Royal Commission was appointed in 1891 to inquire into the matter, and after a full inquiry, in their final report, dated 24th March 1893 (in which the Commissioners were unanimous), they pointed out that only the consumer would get the advantage of any reduction in royalties, and expressed the opinion that "the system of royalties has not interfered with the development of the mineral resources of the United Kingdom, or with the export trade in coal with foreign countries."

In connection with the subject of royalty rents, it should not be forgotten that they vary in amount at different collieries, from a minimum of about 3d. a ton to a maximum of about 10d. Viewed in this aspect, the rent may be regarded as "a differential advantage in production," to the extent of about 7d. a ton.

Assuming that the amount is fixed in proportion to the profit-making capacity of the collieries, the rent enables inferior collieries—that is, collieries hampered by disadvantages—to be worked at the same time as superior collieries—that is, collieries possessing the greatest natural advantages; and on this account it is a question whether the prevalent system of royalty rents, so far from being an incubus on the coal trade, is not a blessing in disguise, in enabling coal to be worked which could not otherwise be worked at the present time.

Whether this is a benefit may be disputed, on the ground that even if the inferior collieries were crowded out, there would still be sufficient competition among the superior collieries to keep down the selling price; and when these collieries had been exhausted, then the inferior properties would necessarily be worked under conditions of cost and price regulated by the competition amongst themselves.

The *immediate* result of the abolition of royalty rents would be that the money hitherto paid to the royalty owner would go into the pocket of the colliery owner; labour would very soon assert its claim to a portion, but in the first falling market, the price would fall until the margin of profit would be reduced to its limit, and the consumer alone would receive benefit at the cost of the royalty owner.

The *ultimate* result of abolishing royalty rents would be a reduced selling price, and the stoppage of the inferior collieries unable to bring down their working cost to the required point, and this point would be about 7d. a ton lower than it is now under the existing system of royalty rents.

Colliery Surveying and Plans.—The value of accurate plans of underground workings is a matter beyond dispute. Many accidents have arisen, and much damage resulted, from inaccurate plans. Inundations of water and gas have occurred through communicating unexpectedly with old workings; buildings on the surface have suffered damage, though sufficient coal has been left for their support, but in the wrong position; barriers of coal covenanted to be left for the protection of a royalty have been unduly thinned; and trespass into adjoining properties has taken place, owing to the plans of workings being incorrect. Experience teaches that old plans, thirty years' old and upwards, should be regarded with suspicion. Too much reliance used to be placed on the magnetic needle, and too little attention paid to the variable declination of the magnetic meridian. Nowadays a colliery staff usually includes a competent surveyor, who devotes his time and attention to the important duties of surveying and planning, under the direction of the manager. At some collieries the manager does the surveying, and every colliery manager ought to be able to do it if need be. Indeed some knowledge of surveying is required in order to pass the examination for First-Class Certificates.

The Coal Mines Regulation Act, 1887, now in force, enacts (section 34) that "the owner, agent, or manager of every mine shall keep in the office at the mine an accurate plan of the workings of the mine, showing the workings up to a date not more than three months previously, and the general direction and rate of dip of the strata, together with a section of the strata sunk through, or if that be not reasonably practicable, a statement of the depth of the shaft, with a section of the seam." "Every such plan must be on a scale of not less than that of the Ordnance Survey of 25 inches to the mile, or on the same scale as the plan for the time being in use at the mine." The Mines Inspector may examine this plan and section, and if they be defective, he may require proper ones to be made. At his request, too, the progress of the workings up to the time of production must be marked on.

A scale which is often adopted for plans of underground workings is $\frac{1}{2500}$, as this enables objects on the surface to be marked on the plan from the maps of the Ordnance Surveys, which are always accepted as correct. Sometimes the workings are plotted on these maps. Two chains per inch is also a favourite scale for these plans, and being a larger scale than the former, shows the workings more clearly. It is a good practice to mark on the plan in coloured letters, at stated distances, the level in feet, taking the bottom of the shaft as a datum line; and also to state the thickness or section of the seam. The main roads are often indicated by being coloured blue, and the return airways by light red. It is well to keep a survey plan, showing merely the line of each survey with the date. This may be useful to prove the date of the workings subsequently, for instance in the event of questions arising as to damage to the surface The main roads, and what may be called the framework of the plan, should be surveyed with a theodolite, or a fast needle compass, but the needle being much more expeditious, may often be used, with proper care and precautions, for filling in the details between these main lines.

A useful form of plan, which is sometimes kept, may be called a "Projected Workings" plan. On it are marked the outlines of all the royalties included in the "take" of the colliery, the lines of faults, dykes, or other geological disturbances, so far as they are known, or may be reasonably assumed, and the workings up to date. On this plan the manager sketches the projected workings of the mine for the guidance of himself and his under-officials. When a group of adjoining collieries are supervised from one office, it is sometimes desirable to show all the workings on one plan at a very reduced scale. For this purpose the small Ordnance scale of 6 inches to the mile is often adopted.

Besides surveying, "levellings" have frequently to be made underground, for such purposes as to determine the thickness of top or bottom stone requiring to be removed to give the desired gradient on haulage roads; or to decide how water may be best removed from dip workings, whether by cutting water levels, or by a syphon; or if a pump is necessary, to determine the position of the pump. Continuous sections of levellings of the main roads from the shaft to the far end are useful, and should be kept for reference. Surveying and levelling are important features in colliery working.

CHAPTER V.

SUPERINTENDENCE OF LABOUR AT A COLLIERY.

THE **Overman** at moderate-sized collieries usually fills also the position of Under-manager, which was created by the Coal Mines Regulation Act 1887 On him largely depends the satisfactory working and good discipline of the colliery. Just as the sergeants have been rightly called the backbone of the British army, so the overmen may be said to be the backbone of colliery underground management. In Northumberland and Durham, the position is as a rule well filled at the present time by men who have begun their career at a very early age as trapper boys, and have worked their way up through every grade of pit work. Th[illegible] are thus practically versed in the work which they superint[illegible] They have for the most part educated themselves under difficul[illegible] —in some respects perhaps the best of all educations—bringing out as it does force of character and natural faculty. Among them are fine specimens of the strong and tenacious, the shrewd and determined North-country type of character.

At some collieries the overman does a large amount of writing or office work, in connection with the making out of the wage bills and pay notes. In such cases he usually goes down the pit at 5 A.M., and "rides" (returns) about 11 A.M., after the back-shift hewers have gone inbye. At the larger collieries, where the wage bills are correspondingly bigger, the tendency is to employ the overman's energies entirely in the pit work. He goes down with the fore-shift deputies or hewers, and the office work is done by clerks. Something may be said in favour of the former arrangement. When an overman calculates the wages of each underground workman, and makes out the wage bill, and also the pay note book, showing the off-takes, and each man's net wages, he is likely to [illegible]ave a more intimate knowledge of what each man is doing, and [illegible] than when this work is left to clerks. On the other hand, In the latter case, the overman is more free to devote both mind and his time to pit work. Forms of daily reports mu by the overman and by the under-manager* are appended.

COLLIERY *PIT* 190

day o'clock M.

FORE-OVERMAN'S REPORT.

Went in at A.M. Barometer Thermometer

Came out A.M.

Flats visited.	Seam.	Hewers' Places inspected.	Remarks.

State of Ventilation :

State of Rolleyways :

" Engine Planes :

" Refuge Holes :

Deputies' Reports :

Accidents :

Horses :

Remarks :

	Fore Shift.	Back Shift.	Total.
No. of Hewers :	...	...	
Coals drawn :	...	...	
No. Hewers idle :	...	...	
No. of persons down the Pit :	...	...	

Signature

---

* Where there is a separate under-manager, as well as an overman, as is th case at large collieries, the former is of course the superior official.

MINE 190

CERTIFICATED UNDER-MANAGER'S DAILY REPORT.

State what part of the mine you have visited...	
Have you or the Manager conferred and advised with all responsible officials? ...	
Breaches of General or Special Rules, and action taken	
Have any circumstances occurred to which you wish to draw attention?	
Have any places been stopped as being unsafe? If so, state why. Also state what has been done to remedy the same	
Fatal Accidents.—State cause and necessary particulars; to report the same to Government Inspector...	
Accidents causing Personal Injury.—Do you consider it necessary to report the same to the Inspector? If so, give the necessary particulars	
General Remarks...	

Percentage of Men off Work in				Pit
"	"	"	in	"
"	"	"	in	"
Average Tons per Shift per Hewer				"
"	"	"		"
"	"	"		"

Signed

The **Back-Overman** has responsible charge of the mine unde ground in the back shift in the absence of the overman. He visit daily, as far as practicable, those parts of the mine which have no been visited by the overman, the object being that every workin place should be visited daily by one of them. On coming to ban after his shift, he confers with the overman, master shifter, an deputies on the state of the mine. He assists the overman in th measuring of the yard work, and, at some collieries, in the makin out of the wage bills. The report made by him may be in th following form :—

MINE 190

PIT SEAM

BACK-OVERMAN'S DAILY REPORT.

Districts travelled and state of Working Places	
State of Ventilation	
Are all Manholes kept constantly clear? ...	
Have any places been stopped as being unsafe? and what action has been taken to remedy the same?	
Have all working places been visited by you or the Overman, or other authorised Official? If not, state cause	
Have you examined the Deputies' Official Reports, and are they properly recorded? ...	
Have you seen that all the Workmen and Boys in your shift are safely out of the Mine, or if not, have you ascertained that they are left in charge of a responsible person?	
Have you conferred with the Overman, Master Shifter, and Deputies on the state of the Mine?	
State the districts in your department where shots are being fired, and are the conditions of General Rule 12 and of the Special Rules under the head "Shot Firing" rigidly carried out?	
Breaches of General and Special Rules ...	
General Remarks as to Stoppages, Accidents, &c.	

BAROMETER, THERMOMETER, AND WATER GAUGE INDICATIONS.

SURFACE.	Barometer.	Thermometer.	Water Gauge.	UNDERGROUND.	Barometer.	Thermometer.	Water Gauge.
Before descending at ..				On descending at			
On ascending at				Before ascending at ..			

Signed

Deputies or Deputy-Overmen.—Each district, or "flat," is in charge of a deputy, under the direction of the overman, or [illegible] overman. The deputy is the competent person required [illegible]

Act (see *General Rules*, Rule 4), who examines the roads and working places before the hewers arrive, fencing off any dange[illegible] place, and making a report of his examination. A simple plan i[illegible] to provide signal boards, having printed on one side, "Working all right, workmen can go inbye," and on the other, "No one to g[illegible] beyond this point," with spaces left for the deputy to affix hi[illegible] signature in chalk. This board is hung at the station, and i[illegible] signed by the deputy each morning after his examination befor[illegible] the fore-shift hewers come inbye. It may be used as a dange[illegible] signal, or to let the men know that all is right. It does not supersede the written report required by the Act, a suitable form o[illegible] which is as follows:—

MINE *SEAM*
DISTRICT

DAILY REPORT BY DEPUTY.

Date 190

I, being the person authorised, hereby certify that I have examined the above-named district, in accordance with General Rule 4 and Special Rules 56 and 57, and report as follows:—

Gas
Ventilation
Roof and Sides
General Safety

Signed

After examining the workings, the deputy meets his men at the appointed station (usually the putters' flat, see Fig. 5, Plate V.), where a wooden chest (deputies' kist) is kept for holding the deputies' tools, and having examined their lamps, and satisfied himself that all is safe, he sets them "inbye."*

The deputies are divided into two shifts. The fore-shift goes down at 2 A.M.,† and are "loosed" at their respective flats by their "marrows," who go down the shaft at 9 A.M., and ride (or return) about 4.30 P.M., after the other men have ridden, one of their duties being to see that the whole of the men and boys are out of the portion of the mine assigned to them. The back-shift deputies then stay to draw timber in "broken" places, which have been

---

* From a carefully kept account at a large colliery having fiery seams, it was found that 27 per cent. of the deputies' time was employed in making the preliminary inspection of the workings required by the Mines Act, and in examining the men's safety-lamps.

† The hours stated throughout this chapter apply to [illegible] the hewing coals from 6 A.M. to 4 P.M.

PLATE V

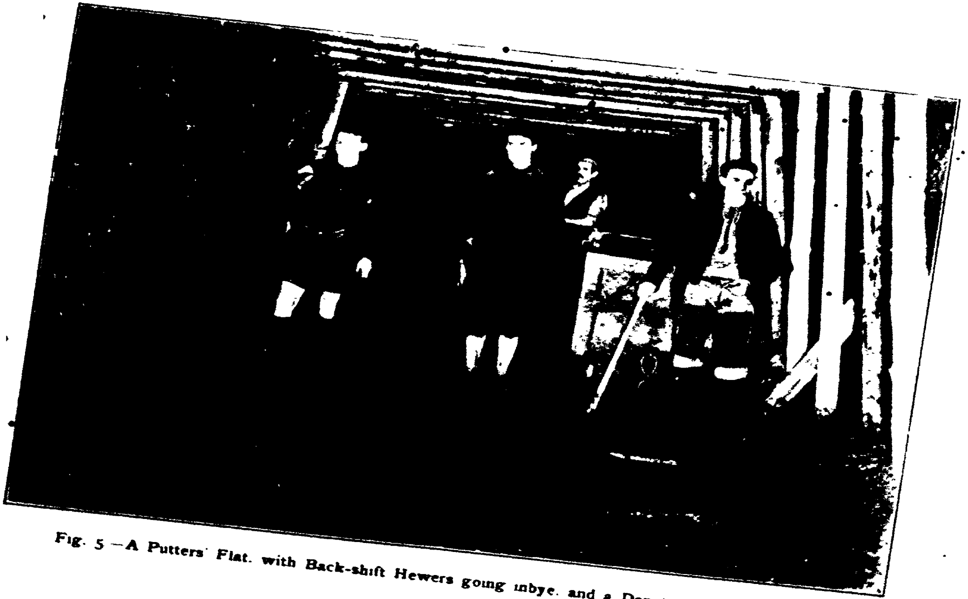


Fig. 5 —A Putters' Flat, with Back-shift Hewers going inbye, and a Deputy in the background

To face page 6

driven as far as required. This is the most dangerous of all pit work, and requires special care and experience. Fig. 6, Plate VI., is a photograph of a deputy engaged in this work. The deputies change shifts each fortnight. They get one short shift (six hours) during the fortnight at the pay week end, when they are working full time (twelve shifts a fortnight). There are variations in this custom at different collieries, as in the case of the shifters.

The **Master Shifter** has responsible control underground in his shift in the absence of the overmen. He keeps an account of the shifts worked by his men. He writes a daily report (see form subjoined), and confers daily with the overmen.

COLLIERY *PIT* 190

MASTER SHIFTER'S REPORT. morning.

Went in P.M. Barometer Thermometer
Came out at A.M.

Districts Inspected.	Condition.

State of Ventilation :
State of Engine Planes :

Bargain Men.		Flat and Seam.	Working at.
Shifters.	**Hours.**		

Night Shift Hewers at Work—

Tubs loaded. District. **No. of Persons in Pi**

Complaints :

Signature

The **Master Wasteman** has the charge of the airways, especially of the return airways, and of the men working in them, of whose time he keeps account. His responsibility is considerable in fiery collieries with long return airways, especially where the roof is difficult to maintain, but there are some collieries where such an official is not required. He also makes a daily report (see form subjoined).

MINE 190

PIT *SEAM*

MASTER WASTEMAN'S DAILY REPORT.

Districts travelled and state of Returns ...	
State of Ventilation	
Have any changes been made in the Ventilation? If so, what?	
Have any Regulators been altered? If so, state particulars of, and reason for alteration	
Have you advised with the Overman and conferred with the Manager or Under-Manager as to the condition of your department? ...	
Breaches of General and Special Rules ...	
General Remarks as to Accidents, &c. ...	

BAROMETER, THERMOMETER, AND WATER GAUGE INDICATIONS.

SURFACE.	Barometer.	Thermometer.	Water Gauge.	UNDERGROUND.	Barometer.	Thermometer.	Water Gauge.
Before descending at ..				On descending at			
On ascending at				Before ascending at ..			

Signed

The **Engineer**, or **Foreman Enginewright**, has charge of the joiners, fitters, smiths, masons, enginemen, and other mechanics, for each department of whom there is usually a foreman, who acts under the directions of the engineer. He keeps a wage book, showing each shift worked by the mechanics, and their wages per fortnight. He has responsible charge of the engines, boilers, ropes,

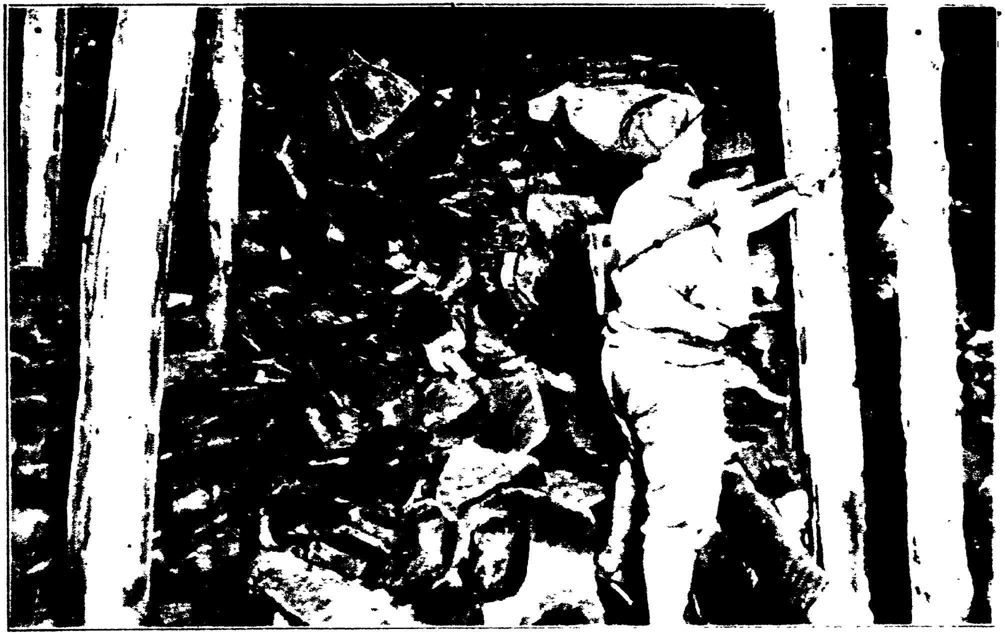


Fig 6 A Deputy Drawing Timber near the Fallen Goaf

and all machinery, and makes the written report of their conditio required by the Act (*General Rules*, Rule 5). Sometimes he keep an account of all materials received, and in what department used acting as storekeeper. His daily report may be in the form give below.

MINE 190

FOREMAN ENGINEWRIGHT'S DAILY REPORT.

Have the external parts of the Machinery, the state of the Guides and Conductors in the Shafts, the state of the Head-Gear, Ropes, Chains, and other similar appliances of the Mine, which are in actual use both above and below ground, been duly examined by the competent persons appointed for the purpose? and state their condition.	
State of Boilers	
Are all dangerous places and exposed Machinery properly and securely fenced?	
Has any part of the Machinery or other works in your department been reported unsafe or defective? and if so, state what action has been taken to remedy the same	
Accidents and cause	
Breaches of General or Special Rules... ...	
Stoppages and Cause	
General Remarks	

Signed

Heapkeeper or **Keeker.**—The men and boys engaged in screening and cleaning the coals, and putting them into waggons, are under the charge of this official, who is responsible to the manager for seeing that this work is properly done. He keeps a wage book, showing the shifts worked, and total wages per fortnight of each man and boy under him; and he makes daily reports, stating the quantity of coal drawn, and how it has been disposed of, on some such form as the following, which of course is varied to suit the particular conditions of a colliery.

COLLIERY

day 190 .

	Drawings.		Teamed.		Filled.		Hewers.			
	Score.	T.	Score.	T.	Score	T.	Fore.	Back.	Off.	Total.
To-day										
Formerly										
Total ..										

Vended.

Destination.	Round.			Unscreened.			Nuts.			Small.			Rough Small.		
Totals															
Tons, viz.															

Heap.

Resting

Produce.

Tons per Score

Round per cent.

In some cases the heapkeeper keeps an account of the timber and rails sent down the pit, and an account of all goods received by rail, stating the number of truck, descriptions of goods, from whom, when arrived, and when unloaded—in which case he may be said to act as traffic manager as well as heapkeeper.

CHAPTER VI.

ARRANGEMENT OF LABOUR AND SYSTEM OF WAGES.

SOME knowledge of the daily routine of a colliery, of the different classes of labour employed there, and of the system of wages in vogue, is essential to a proper understanding of the subject of colliery working. In the present chapter, accordingly, will be given a detailed description of these matters as usually arranged at collieries in Northumberland and Durham.*

Days and Hours of Coal Drawing.—Work begins at 6 A.M. At this hour the onsetters, putters, drivers, rolleywaymen, and other day-shift "off-hand" men and boys (so called in contradistinction to the actual coal-getters or hewers go down the shaft, and then coal drawing commences. The usual practice now is that it goes on for ten hours, till 4 P.M. At the beginning of 1891, the Durham Coal Owners' Association, at the request of the Miners' Union, granted a reduction of one hour. Several large collieries in the east of Durham draw coals for twenty hours daily, employing two shifts of off-hand men and boys, and three shifts of hewers. In Northumberland there are both ten-hour and eleven-hour pits. The time spent in actual coal drawing is usually about one hour less than this, as in those cases where the men go down and up the same shaft as the coals, a good deal of time is taken up in sending down the back-shift hewers and drawing the fore-shift. At some collieries it is customary for the banksman or heapkeeper to keep a daily record of every stoppage in coal drawing, stating the duration and cause of it. These entries are added to the daily report, an example of which form of report, made by the heapkeeper to the manager, is set out below :—

---

* The classes of labour employed, system of wages, and other matters appertaining to daily routine of collieries in other districts than here specified, will be found dealt with in Chapters XV., XVI., XVII.

COLLIERY *PIT*

HEAPKEEPER'S DAILY REPORT.

Pit Drawings.	Scores.	Tons.	**Total Tons.**
Pit			
Pit			
Pit			

	Best Waggons.	Bottom Waggons.	Nuts Waggons.	Small Waggons.	**Dust Waggons.**
Vend ...					

	Best Score Tubs.	Small Waggons.	Dust Waggons.	Produce.
Filled ...				
	Best Score Tubs.	Small Waggons.	Dust Waggons.	
Teamed ...				

Accidents and Cause :—

Stoppages and Cause :—

Waggons Recast	Stones lbs.	Brass lbs.	Bad Coal lbs.	Total lbs.	Small lbs.	**Names.**
Pit						
Pit						
Pit						

General Remarks :—

Signed

The pay-day is each alternate Friday for the fortnight endin on the previous Saturday, and the Saturday following the pay-da is a general holiday, so that the days per fortnight on which colliery working full time draws coals are eleven. On "baff Saturdays—that is, the Saturdays in the alternate week to pa week—the pit "hangs on"—that is, starts coal drawing—two hour earlier, at 4 A.M. instead of 6 A.M., and draws coals for one hour les than usual, stopping at 1 P.M.* The various shifts of men all star two hours earlier than usual.

Hewers.—The coal-getters or hewers are divided into two shifts each fore-shift hewer having a partner or "marrow," who follows him in the same working place in the back-shift, the two usually sharing their joint earnings. As a rule they change shifts every week, the fore-shift hewer of one week coming in back-shift the next, and *vice versâ*. In ten-hour pits the fore-shift goes down at 4 A.M., and remains in the "face" till "loosed" by the back-shift, which goes down at 9.30 A.M., and reaches the "face" about half an hour later† on an average, the time of course depending on the distance from the shaft to the working places, and the means of covering this distance. Frequently where main and tail rope haulage is in use the hewers are taken inbye in a train of empty coal tubs. Allowing half an hour for travelling between the shaft and the face each way, the hours worked in the face by the hewers are not more than 5½ daily, or 60 per fortnight, assuming that the hewer works on each of the eleven days, which is not always the case.

The fore-shift hewer has about two hours in the face before he can begin to fill tubs, as the putters do not get to work before 6.30 A.M. In hard coal seams this time is usefully employed by the hewer in "kirving" his place and making a "jud"—operations which will be found described in Chapter X., page 162 (see also Fig. 7, Plate VII.); but in soft seams, and where "round" coal (that is, coal running large, such as is usually required for household consumption) is not a matter of importance, it is apt to be to some extent wasted.

Not long ago, in the county of Durham, it was the practice at soft coal collieries for a class of young men, known as "putting

---

* These hours vary somewhat at different collieries.

† This system of two shifts of hewers, with one shift of off-hand men and boys, has existed and been followed for generations in Northumberland and Durham; and it is the general adoption of this system which makes the proposed Eight Hours Bill so unsuitable for colliery working in these counties.

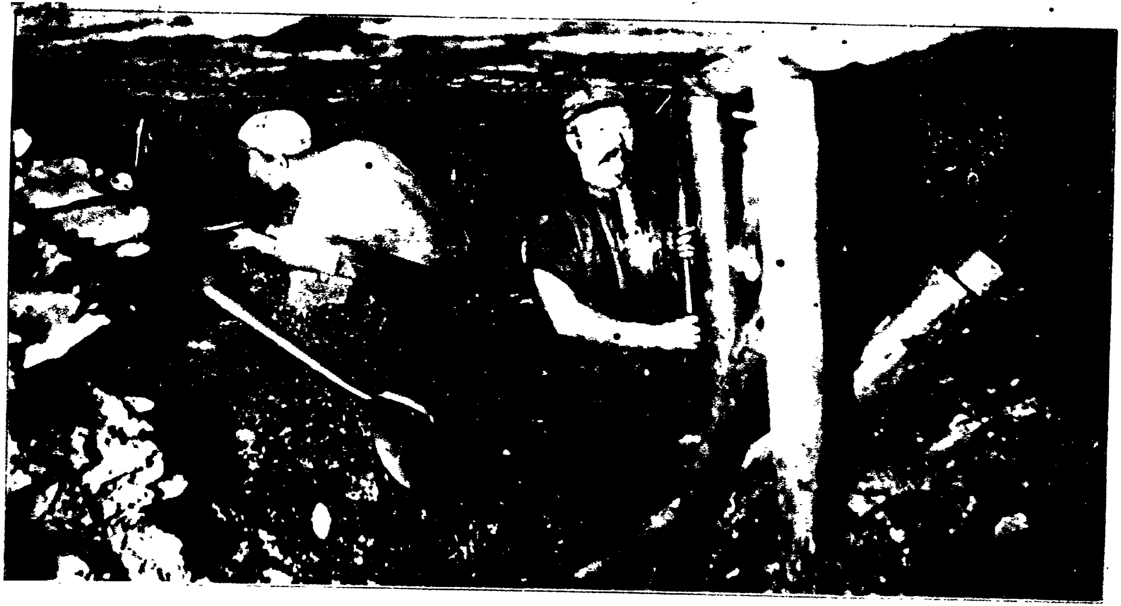


Fig. 7 A Hewer 'kirving' in a Thin Seam and a Deputy Setting Timber

hewers," to come down at 4 A.M. with the hewers, and "put" tubs until the regular putters came to work, and then hew till 2 P.M.; the advantage of the arrangement being that it kept the hewers fully occupied during the first two hours. This practice, however, was objected to by the Durham Miners' Union, and was given up. But it is a general custom, both in Northumberland and Durham, to employ "putting hewers," who come to work at the same hour as the regular putters, and if any of the latter are absent, the "putting hewers" are called upon in turn to supply their places, but in an ordinary way they hew from 6 A.M. till 2 P.M. There are also "hewing putters," who in an ordinary way "put," but when there is not a sufficiency of "putting" work at their "flat," they are allowed to hew.

The working places are divided by lot amongst the hewers every three months. The process of drawing lots is called "cavilling." Each pair of hewers are "cavilled" to a working place, where they must remain during the quarter year, unless they make a mutual arrangement with another pair to exchange places with them. There are recognised rules, determining what working place a hewer must take, when the place to which he was cavilled is worked out during the quarter. Copies of such rules, in use in collieries in the counties of Northumberland and Durham respectively, will be found in the Appendix, page 301.

In the majority of Durham collieries—perhaps more especially in the East Coast pits—the hewers are paid by the "score," a time-honoured but somewhat out-of-date fashion of reckoning, but one tenaciously adhered to by the men, with their usual conservatism. A score in the Wear district is equivalent to 21 tubs, of either 6, 8, or 10 cwt., or thereabouts. In the neighbourhood of the Tyne, and throughout those mines in Northumberland where this mode of reckoning is still in vogue, 20 tubs constitute the score. An "average weight" is kept by the weighman of the tubs filled by each hewer, who is paid at the rate of the score price in operation in his district, and all over-plus at the same rate. If his average is under standard weight, he suffers a corresponding reduction.

There may be, and usually are, several score prices in the same seam, but, as a rule, one district has but one score price if the same description of work is pursued throughout it. "Whole" or [illegible] working" prices are naturally in advance of "broken" or "second working" (removal of pillars) prices—the coal being [illegible] won in the latter instance, owing to the weight of the [illegible] incumbent strata taking effect on the pillars. In most instances it is agreed between masters and men that "broken" prices cannot be enforced by the former until a stipulated area (usually 1,200 square feet) of pillars has been extracted, nor shall any place be paid "broken" price unless within 60 yards of the goaf. The score price of a district may be determined somewhat after the following manner:—

(1.) At a Durham colliery in the year 1877,* working the Low Main seam with a section of 3 feet 10 inches of clean coal, it was reckoned that in a 2-yard "place" an average hewer ought to "take off" per shift a 2 feet 6 inches "jud.". The calculation would then be: 6 feet multiplied by 2.5 feet multiplied by 3.83 feet = 57.45 cubic feet = 2.136 cubic yards; 18.83 cwt. (the weight of a cubic yard of coal) multiplied by 2.13 = 40.107 cwt.; 40.107 cwt. divided by 8 cwt. (the standard weight of a tub) = 5 tubs.

5 tubs at 14s. per score	3s. 4d.
Yard work at 1s. 10d. per yard, for 2 feet 6 inches ...	1s. 6d.
Per hewer per shift	4s. 10d.

The county average at this time was 4s. 8d.

(2.) In a second instance, the thickness of seam was 3 feet 9 inches clean coal; length of jud, 3 feet; width of bord, 15 feet; 3 feet 9 inches × 3 ft. × 15 feet = 6.25 cubic yards = 5.85 tons of coal. And the average weight of tubs drawn from the Low Main seam during the previous pay being 8.42 cwts., 5.85 ÷ 8.42 = 13.89, or nearly 14 tubs.

From daily observation it may be safely inferred that here the average hewer can easily hew and fill 7 tubs during his shift in the "whole" working, and allowing him 5s. for his day's work, the score price is fixed at 15s.

In order to induce men to put forth greater energy, and also the better to drive their places, a yard price is usually added in bord and pillar pits, the amount being dependent on the description of place driven—that is, on the width and the angle it makes with respect to the bordways cleat, or main cleavage planes of the coal. For instance, in the Low Main seam quoted above, the yard prices ranged thus:—

---

* It has been thought advisable to quote actual cases for all the examples, as being more reliable than figurative instances.

Winning headways	2 yards wide	1s. 8d.	per yard.
" "	3 "	1s. 4d.	"
Cross-cuts	3 "	1s. 6d.	"
Walls (North and South)	2 "	1s. 6d.	"
" "	3 "	1s. 2d.	"
Bords (East and West)	2 "	1s. 4d.	"
" "	3 "	0s. 8d.	"
Taking off side coal		0s. 5d.	
Skirtings, jenkins, and splitting pillars			

Sometimes winnings are "let" *through* the colliery previously to the quarterly cavilling, when each "set" of men gives in its particular price, such yard price being over and above the actual score or tonnage price, which is paid as usual. Then there are such refinements and details as "bordways cross-cuts" and "headways cross-cuts," according as the cross-cut place approaches to true bordways or headways course respectively. Many other items have also to be considered by the colliery viewer in his daily routine in this department of his work—such as consideration for local hard coal, working wet, scalloping, for "hitches," "troubles," "balks," "ramble," and what not, for the determination and settlement of which no hard and fast rules can be stated; the questions raised being such as need for their settlement only common-sense joined to experience.

As regards the mode of paying for the taking down of the "ramble," or "following stone," in the seam already mentioned, the hewers, for taking down and casting this back, were paid 2d. per inch (in thickness) per score of coals filled, when the ramble was over 9 inches thick, but when below this thickness they received no extra remuneration.

In many Northern collieries the tonnage price is in operation instead of the score price, and it is certainly the simplest mode of payment. In the thinner seams, a very frequent system of tonnage payment is to regulate the price paid by the height of the seam—that is to say, the greater the thickness of the seam the less the price per ton, and *vice versâ*, the overman measuring the height in the working places every fortnight.

The course pursued with respect to under-filled and dirty tubs may be stated thus:—If the banksman notices that a tub is not well filled, he may "set it" to the "weigh." The tub, if it proves to be under weight, is said to be "set out" by the banksman. Tubs thus set out suffer the recognised reduction; but tubs under weight which are set out by the weighman are included in the average weight account, which, of course, they lower. As an example, the deductions on this account at a large colliery (the standard weight of a tub being 8 cwt.) were as follows:—

For Seam—
56 lbs. under weight in a tub of round coals } amount to be deducted, 3d.;
28 " " small "

For and Seams—
56 lbs. under weight in a tub of round coals } amount to be deducted, 5d..
28 " " small "

The quantity of stone, slate, band, or foul coal for which a tub could be "laid out," and the deductions made for the same, were at the colliery under consideration, 20 lbs., deduction 4d.; 25 lbs., deduction 5d.; 30 lbs., deduction 8d., except when the value of the tub was below 8d., when its full value was confiscated.

The tons hewed per hewer per shift vary from about 2½ tons in the hard steam coal collieries of Northumberland, to over 6 tons in the soft-coking and gas-coal seams of West Durham. The hewing price per ton, exclusive of percentage, varies greatly.

There is, however, an average standard wage for hewers, agreed upon between the Owners' Association and the Miners' Union in each county. When the hewers' earnings at any colliery are at least 5 per cent. above or below this recognised county average, a readjustment of the prices paid for hewing can be obtained by either side. This is one of the rules of the Joint-Committee, consisting of representatives of the Owners and of the Miners, with an independent chairman, which exists for the sake of deciding questions about wages arising at individual collieries. (The larger questions affecting the whole county—such as general advances or reductions in wages—do not come within the jurisdiction of this Committee.) Its bearing on colliery management is shown by this statement of cases decided for the county of Durham:—

	Cases brought by Workmen.	Cases brought by Owners.	Total.
1880-89 (average) ...	389=61 per cent.	243=39 per cent.	632
1890-99 " ...	547=69 "	244=31 "	[illegible]
1900	476=73 "	174=27 "	650
1901	568=62 "	343=38 "	911
1902	584=60 "	381=40 "	965
1903	658=61 "	406=39 "	1,064
1904*	583=64 "	318=36 "	901
Average over the whole	543=64 "	301=36 "	844

* The falling off in the number of cases in this year was due to the Committee being in abeyance for a period owing to a difficulty in agreeing on a Chairman.

The general tendency appears to be that the cases increase in number, and that the proportion brought by the workmen is larger in good times, as in 1900. How the cases have been decided is shown below:—

	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	Averages.	Totals.	%
Referred to local arbitration ...	80	111	102	138	115	66	131	114	174	153	118	1,184	14
Settled by agreement between parties ...	211	240	229	248	243	359	428	449	484	432	332	3,323	40
Decided by Committee ...	202	251	202	233	201	128	103	242	213	142	207	2,067	24
Withdrawn .	187	240	220	130	159	91	140	156	178	170	168	1,686	20
Ruled as out of jurisdiction of Committee	21	17	31	15	13	6	10	4	15	4	14	136	2
Totals ..	701	859	850	704	731	650	911	965	1,064	901	839	8,396	100

It is noticeable that the largest proportion of cases—40 per cent. of the whole—have been settled by agreement* between the two parties in dispute after being brought before the Committee. The proportion decided by the Committee is only 24 per cent., and those referred to local arbitration 14 per cent. of the whole.

---

* It is interesting in this connection to determine the results of the action of Conciliation Boards throughout the Kingdom, and the following table summarises the work of such boards in the mining industry during 1903:—

Board.	Number of Cases Reported in 1903 as			Number of Cases Settled during 1903.		
	Considered by Board	Withdrawn or settled independently.	Under consideration at end of 1903.	By Conciliation	By Arbitration.	Total.
Federated Districts ...	2	...	...	...	2	2
Northumberland Conciliation Board	4	..	...	2	2	4
Northumberland Joint-Committee	117	41	7	58	11	69
Durham Conciliation Board	10	..	1	8	1	9
Durham Joint-Committee ...	1,064	677	15	213	159	372
Cumberland	1[illegible]	...	2	8	1	9
West Yorkshire	15	4	2	8	1	9
Forest of Dean	1	...	..	1	...	1
Radstock	3	...	...	3	...	3
South Wales and Monmouthshire...	35	...	6	...	29	29
Cambrian Collieries	4	1	3	...	...	...
Scotland	1	..	...	...	1	1
Cleveland (iron mining) ...	11	3	...	6	2	8

How far the action of the Joint-Committee prevents local strikes and stoppages of work is a question not easy to answer. In spite of its existence, there were during the year 1890, 86 stoppages, involving the loss of 354 days' work; and in 1891, 120 stoppages, with 362 days' work lost. In most of these cases the men were acting contrary to the opinion of the officials of their Union. The worst feature of Joint-Committees is their tendency—which is quite contrary to their own desire or intention—to usurp the functions of the colliery manager, and to increase the demands made by the workmen. Cases which ought to be settled at the colliery, and others which ought never to arise, are brought before it for no sufficient reason, and merely in virtue of its existence.

The Rules of the Joint-Committees of the Northumberland and Durham Associations, respectively, are set out in the Appendix.

We come now to the numerous and varied classes of men employed for "off-hand labour" (see pages 39, 74, and 98), who in many cases are (like the hewers) paid "by the piece."

Putters—These are lads from sixteen to eighteen years of age, who convey the tubs—by the aid of ponies when the height of the road allows it—between the hewers' working places and the putters' "flat" or siding, where the tubs are made up into sets and taken away by the drivers. Sometimes men are employed for hand-putting. Fig. 8 is a photograph of a hand-putter starting from the putters' flat with an empty tub.

The putters are paid according to the number of full tubs they "put" from the face to the flat. A price per score of tubs is fixed for the first 130 yards' distance in the case of pony-putters, and 80 yards in the case of hand-putters. For every additional 30 yards in the former case, and 20 yards in the latter, an additional price per score is paid. For example, at a certain colliery in Durham, for the first 130 yards, pony putting, 11¼d. per score of tubs of coal put is paid, and constitutes the standard price; for every successive 30 yards in distance, an additional penny per score is paid. Thus, presuming the average distance put at a flat amounts to 240 yards, 240 − 130 = 110, and 110 ÷ 30 = 3 and 20 over. Then, first, 130 at 11¼d. = 11¼d.; three, 30 at 1d. = 3d.; (over), 20 at 1d. = 1d.; total, 1s. 3¼d. This amount (1s. 3¼d.) will be the putting score price, or "rank," of the flat.

The distances from the putters' flat to the working places have therefore to be measured frequently. To avoid this trouble, sometimes a "standing rank" is fixed—that is, a price per score which does not vary, but which is estimated to be a fair average for the various distances "put" in the different districts of the pit. The method of keeping account of the putter's work is the same as for the hewers. Each putter has a bundle of "tokens," bearing a distinctive mark or number, by which his tubs are known. He attaches one of these to every tub he puts, and when the tub comes to bank at the surface, this token, as well as the hewer's token, which is also attached to each tub, is taken off by a boy employed for the purpose, and hung up in the token cabin. Thus the weighman at bank knows, and keeps account of, the number of tubs put by each putter and filled by each hewer daily.

The putters change their flats, or districts, each quarter year, cavils being drawn for them at each quarterly cavilling. Every morning (or in some pits once a fortnight) the deputy in charge of the flat apportions the hewers amongst the putters, and determines by some simple method of drawing lots, which hewers each putter shall take.

Stonemen.—Other off-hand men who are often paid by the piece are stonemen. Their shift is eight hours from "bank to bank," and they go down at various times. Their work, which may be termed the "dead" work of the mine—consisting as it does in a very great degree, if not entirely, of opening out and development—constitutes one of the most important branches of the underground department. Fig. 9, Plate VIII., shows a stoneman at work with a hand-drilling machine in the face of a stone drift. The payment of this kind of work is in many cases a matter of bargain, and in determining the price, many and various circumstances have to be taken into consideration.

For the sake of clearness, the several descriptions of stone-work may be considered under the heads of (i.) Canches; (ii.) Ridding; (iii.) Drifts; (iv.) Staples; and (v.) Miscellaneous Bargain Work.

(i.) CANCHES.—These may be of three kinds—top, bottom, or side. The construction of air crossings, in so far as the stonework is concerned, may also be regarded as coming within this category.

Where the mode of calculation adopted is so much per inch in height of canch for a standard width of 6 feet, the following may be taken as average basis prices:—

Top coal	$1\frac{1}{4}$d.	per inch.
Bottom coal	$\frac{3}{4}$d.	„
Top stone, Blue shale (soft)	$1\frac{1}{2}$d.	„
„ „ (fairly soft)	$1\frac{3}{4}$d.	„
„ „ (fairly strong) ...	2d.	„
Bottom stone (soft)	$1\frac{1}{2}$d.	„
„ „ (hard)	2d. to $2\frac{1}{2}$d.	„
Top stone (post or sandstone) ...	$2\frac{1}{2}$d. to 3d.	„
Bottom stone (post)	$2\frac{1}{2}$d.	„

These prices are dependent upon the condition that explosives are used in working the stone. The matter will be better understood, if a few specific examples be given.

First Example.—New drift-way; taking off side for new landing:—

Dimensions. { Has to be finished 10 feet × 6 feet 6 inches = 65 square feet.
Is at present ... 8 feet × 6 feet 6 inches = 52 square feet.
2 feet × 6 feet 6 inches = 13 square feet.

$13 \times 3 \div 27 = 1.44$ cubic yards. Character of stone, shale, very broken and fairly soft, for which the price was $1\frac{3}{4}$d. per inch. This gives 2s. $7\frac{1}{2}$d. per cubic yard, or 3s. $9\frac{1}{2}$d. per lineal yard. Decided to pay 4s. upon a calculation made as follows:—

Thickness of canch = 2 feet = 24 inches; 24 inches at $1\frac{3}{4}$d. = 42d.

$$\frac{42 \times 6 \text{ feet } 6 \text{ inches (width of canch)}}{6} = 45\tfrac{1}{2}\text{d} = 3\text{s. } 9\tfrac{1}{2}\text{d. per lineal yard.*}$$

A disadvantage which the men had to contend with in this instance was their having to "shoot" two sides (canches) instead of only one. At the same time, there were two advantages to put against this—namely, there was no "stowing" to do, and the owners supplied the explosives.

Second Example.—East incline, top canch: thickness of canch, 8 feet 6 inches, to run out to 4 feet, thus averaging 6 feet 3 inches. Character of stone, white sandstone. Consider as three canches thus:—

	£	s.	d.
First canch, 2 feet 3 inches at $2\frac{1}{2}$d. per inch	0	7	10
Second canch, 2 feet at $2\frac{3}{4}$d. per inch	0	7	10
Third canch, 2 feet at 3d. „	0	8	6
Making, per lineal yard	1	4	2

---

* The standard width for all these inch prices is 6 feet: 3s. $9\frac{1}{2}$d. ÷ 1.44 (cubical contents of canch) = 2s. $7\frac{1}{2}$d. per cubic yard.

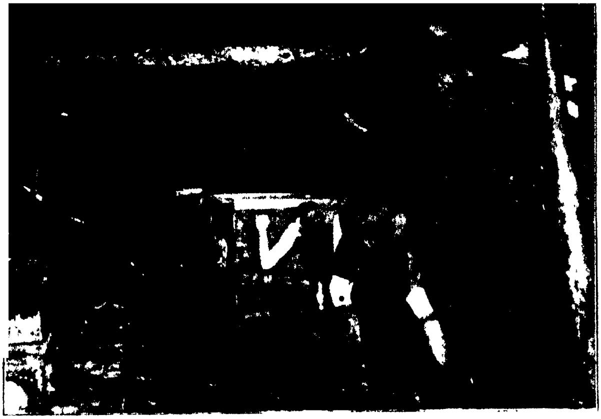


Fig. 8 A Hand Putter at Work

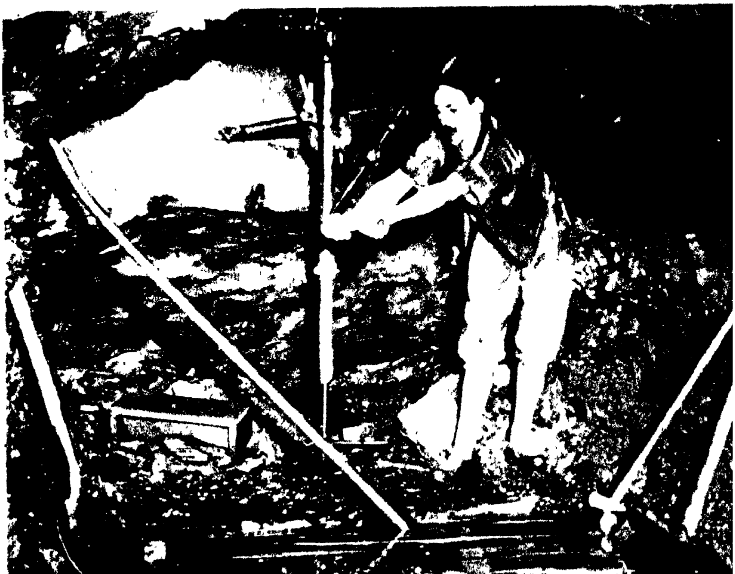


Fig 9 A Stoneman at Work with a Hand drilling Machine in the face of a Stone D

The width of canch was 9 feet at top and 8 feet at bottom. It wa let at £1. 4s. 2d., less 10 per cent. for cost of explosives (gelignit and Settle's water cartridge), say, £1. 2s. per yard.

It will be noticed that the thick canch is divided into three, i being difficult to shoot down a canch of sandstone (post) much over 2 feet thick without waste of explosives, and at the expense o the regularity of the place. The first canch is always the easiest to shoot.

Third Example.—Slanting staple in east side Main Coal return, Low Main seam (December 1888). In this case, the staple had to be slanted, in order to enlarge the return, as an increased quantity of air was required (inbye) in some of the new districts then opening out; and it was desirable also that these districts should be provided with a better travelling road. The use of explosives (with Settle's water cartridge) was allowed, as there was no air from broken workings passing this part of the return. It was arranged to work continuously, with three shifts of two men each.

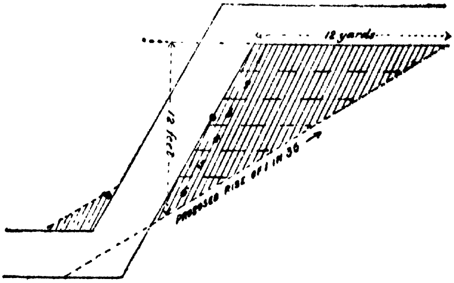


FIG. 10.—SKETCH ILLUSTRATING METHOD OF CALCULATING COST OF STONE WORK IN MAKING A SLANTING STAPLE.

The mode of calculating the cost was as follows, there being six canches in all, each 2 feet thick and 6 feet wide (see Fig. 10):—

						£	s.	d.
First canch,	2 ft. thick and	12 yds.	long, at 2½d. p. in.	= 5s. 0d.	per yd.	= 3	0	0
Second	,, ,,	10	,, 2¾d. ,,	= 5s. 6d.	,,	= 2	15	0
Third	,, ,,	8	,, 3d. ,,	= 6s. 0d.	,,	= 2	8	0
Fourth	,, ,,	6	,, 3¼d. ,,	= 6s. 6d.	,,	= 1	19	0
Fifth	,, ,,	4	,, 3½d. ,,	= 7s. 0d.	,,	= 1	8	0
Sixth	,, ,,	2	,, 3¾d. ,,	= 7s. 6d.	,,	= 0	15	0
						12	5	0

The total cost thus working out to £12. 5s., the men (contractors), in order to make fair wages, would have to finish the work well within a fortnight.

Fourth Example.—Taking up seggar, or fireclay, in Main Coal seam (September 1889). Paid at the rate of 2½d. per inch, the stratum being of a particularly hard gritty nature. In another seam, taking up fireclay was paid at the rate of 1½d. and 1d. per inch, usually the latter; but when the bed was only from 6 inches to 8 inches thick, at 1½d. Clearing away fallen stone or coal lying on top of the seggar was not included in the canch price, but was paid for extra, according to the extent.

An ordinary width of canches is, in main ways, 8 feet wide;* in branch ways, 7 feet wide. When shooting top or bottom canches, the width being decided, no extra width that the men may make, over and above this, is taken into consideration when measuring their work. The powder or other explosive will of course expend itself somewhat in the sides, but little extra work is entailed thereby in dressing back, stowing, &c.

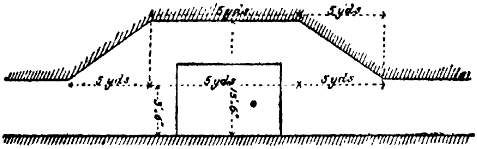


FIG. 11.—SKETCH ILLUSTRATING METHOD OF CALCULATING COST OF STONE WORK IN MAKING AN AIR-CROSSING.

Fifth Example.—Estimated cost of an air-crossing to be shot out in Low Main seam (1887), the dimensions being as follows (see Fig. 11):—

	Feet	Inches.
Allowance for arching	1	0
Height of return air-way above arch	6	0
Height of in-take air-way beneath arch	6	6
Total height	13	6
Deduct height of seam...	3	6
Height of stone canch	10	0

---

* Assuming the main-and-tail rope system of haulage to be adopted. In the case of endless chain or rope being the system of haulage, the width of canches on main roads would be from 9 to 12 feet.

Amount of stone to be taken down, 10 feet × 8 feet × 30 feet = 2,400 cubic feet = 88.9 cubic yards, which at 6s. 9d. per cubic yard = £30 total cost. The following is the manner of calculating the preceding price:—

				Post Stone.
First 2 feet	at	3d.	per inch	72d.
Second	„	3½d.	„	84d.
Third	„	4d.	„	96d.
Fourth	„	4½d.	„	108d.
Fifth	„	5d.	„	120d.
				480d.

The place when finished to be 8 feet wide — say, 9 feet.

$$\frac{480\text{d.} \times 9 \text{ ft.}}{6 \text{ ft.}} = 720\text{d.} = £3 \text{ per lineal yard.}$$

£3 × 10 yards = £30 : 88.9 = 6s. 9d. per cubic yard.

The inch prices must sometimes be altered to suit special circumstances, as in the following case:—

Sixth Example.—Air-crossing over barrier way in Low Main seam (June 1889). The return and in-take airways are "cross-cut on," as the pit-saying is, and as shown in Fig. 12. Now this work could not be let at the 3d. per inch basis price, although the stone was ordinary "post" (sandstone), as a difficulty was experienced in "tailing out" the canch, so ½d. per inch was added. There was, of course, more tailing out to do than if the air-crossing had been a rectangular one.

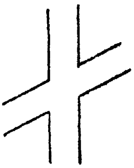


Fig. 12.

(ii.) RIDDING.—Actual examples again will best explain matters in this class of work.

First Example.—Enlarging gateways, drifts, &c., in Low Main seam (November 1887). This was paid at the rate of 3s. per cubic yard, putting and stowing being close at hand. All stone was wedged down, and no explosives were allowed to be used. Character of stone, shale and sandstone.

Second Example (February 1888).—Cleaning up and laying way for tubs, preparatory to commencing to take off pillars in Dale-way seam. All along the headways the top coal was "up-standing," but a band of stone below had fallen, and was lying by the sides, where it had been placed by the hewer when working in the whole. There were 18 yards in the bord where the top coal had fallen (see Fig. 13).

As to headways. Averages measured from the *top of the seam*, in order to determine how much *must* have fallen, and taken every 10 yards. Average = 10 inches. 10 inches × 9 feet wide × 33 yards long, at 1¼d. per inch, 10 inches × 1¼d. × $\frac{9}{6}$ = 1s. 6d. per yard.

As to bords (107 yards). The thickness of fallen stone was greater here than along the headways, and in 18 yards of it the top coal had fallen. Regarding this as two canches, the calculation is—(*a*) 107 yards × 16 inches × 5 feet wide, 16 inches × 1¼d. × $\frac{5}{6}$ = 1s. 4d. per yard; and (*b*) 18 yards × 20 inches × 9 feet wide, 20 inches × 1¼d. × $\frac{9}{6}$ = 3s. 1½d. per yard.

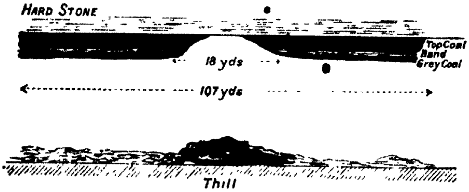


FIG. 13.

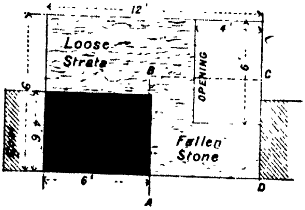


FIG. 14.

SKETCHES ILLUSTRATING METHODS OF CALCULATING PRICE FOR RIDDING.

Third Example.—Putting across "bord rooms" was always paid at the rate of 5s. per lineal yard, *plus* the current county percentage above standard wage. This was the only bargain work that varied with the percentage advances and reductions.

Fourth Example (see Fig. 14).—Enlarging a return air-way, Main Coal seam (1887). The air-way to be made 12 feet wide by 9 feet high. The present dimensions are 4 feet wide by 6 feet high. The original road A B C D, owing to the falling of the stone, had got partially filled up and altered to the position indicated in Fig.

14. The coal was to be hewn out and paid for at the district score-price.

4.5 feet × 6 feet = 27 square feet of coal.
4 feet × 6 feet = 24 area of opening.
—
51

12 by 9 = 108 square feet sectional area of finished air-way. 108 − 51 = 57 square feet sectional area to be ridded.

57 square feet per lineal yard = 6 cubic yards.

The price paid was 1s. 1d. per cubic yard = 6s. 6d. per lineal yard.

(iii.) STONE-DRIFTS.—When contracting for the driving of stone-drifts—or, indeed, stone-work operations of any description—a formal agreement is often drawn up and signed by the two parties concerned. To quote from an actual instance:—

........................*COLLIERY*, 18th October 1887.

NEW STONE-DRIFT—MAIN COAL.

AN AGREEMENT between A. B. on behalf of the Coal Company Limited, the one party, and C. D., E. F., &c., the other party, relative to the driving of the above-named stone drift.

First Part.—The contractors agree to drive the stone-drift in a straight and uniform manner. It is to be finished 6 feet high by 6 feet wide, and to rise at the rate of ½ inch per yard. The stones to be filled into a tub, "put" to the siding. The men to set all timber and erect the brattice for the ventilation; and to keep the drift in a safe and workable condition to the satisfaction of the master shifter.

Second Part.—The owners agree to provide the explosives and blasting materials. Also to provide and sharpen all necessary gear. The timber and brattice to be taken to the drift way end at the owners' expense.

The rate of payment to be £1. 14s. per lineal yard. Six inches of coal or whinstone to break the bargain.

To be let for twenty (20) yards, but can be stopped at any time should the management deem it necessary.

Signed on behalf of the owners,

Manager.

Signed on behalf of the men,

} *Contractors*

Witness to the above signatures..............................

In the above case the stone was sandstone and shale mixed, and the price per cubic yard was 8s. 6d. = per square foot 11.33d. Below is another form of specification, which has been used in "letting" stone-drifts to be driven by contract:—

COLLIERY.

SPECIFICATION AND DESCRIPTION OF A STONE DRIFT TO BE DRIVEN FROM THE SEAM TO THE SEAM IN THE PIT.

I. The drift to be driven 9 feet wide and 7 feet high, and to rise $4\frac{1}{2}$ inches per yard, passing through all strata between the seam and the seam, an account of which is provided herewith.

II. The drift to be driven by the marks as directed by the manager of the colliery.

III. It is expected that the gradient will be uniform, but it may be necessary to vary it as circumstances arise.

IV. The contractors to find all gunpowder—or other explosives that may be used—candles and other stores; the owners to provide and sharpen the gear, including a drilling machine and drills.

V. The contractors to lay all plates, and to set any timber that may be necessary for their own safety; and to put in all air-tubes or ventilation brattice; the owners providing the same.

VI. The contractors to fill all stones, coals, and other material produced by the drift into tubs provided by the owners, who will also find the means for leading away the same. All coals to be filled free from stones or dirt.

VII. The drift to be driven and worked by not less than three men in the face at any one time.

VIII. The contractors to be paid once a fortnight on the usual and accustomed pay day within *five per cent.* of the sum earned, such five per cent. being retained in hand by the owners as a guarantee for the full and satisfactory performance of the work.

IX. The drift will be commenced within a few yards of the main east winning in the seam, and as there will be a tail end of top stone to shoot down before the drift is set in fast, it is agreed that the measurement for payment of contract price shall start at or be reckoned from the centre of this tail end. It is further agreed that as soon as the seam is touched the contract shall terminate.

X. The work to be performed in a workmanlike manner to the entire satisfaction of the manager of the colliery, upon whose certificate only the money will be paid.

XI. Written tenders to be handed in at this office on or before the day of 190 .

Signed

Colliery Manager.

COLLIERY OFFICE,
190

For stone-drifts, the following basis prices answer fairly well in the majority of cases. For sandstone: price 10s. to 11s. [illegible] per cubic yard in a *regular* stone-drift of 6 feet by 8 feet, or [illegible] by 8 feet or thereabouts. The price will be found to vary [illegible] as the width of the drift; for the wider it is, the better the [illegible] shoots. If the drift was wider than 8 feet, it would let for less than 10s. per cubic yard. For shale: price per cubic yard, 6s. to 7s. 6d. for the same sizes as the above.

If a drift is driven as an incline, not only are the difficulties of "putting" greater than if it was level, but the shooting of the stone is not so easily effected, as it is worked against the grain, as it were—that is to say, it is not parallel to the planes of bedding or stratification—unless, indeed, the strata are much inclined, which is rarely the case in the Northern coalfield. Furthermore, if, as sometimes happens, a thin bed of softer stone "puts in"—which is reckoned a godsend to the stone-man—an inclined drift does not long retain this advantage; hence allowances must be made in the bargain price when letting inclined drifts.

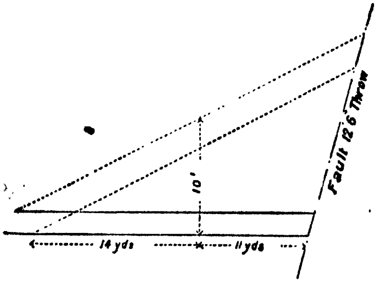


FIG. 15.

First Example.—Estimated cost of putting up an incline in east back headways for return air-way, as illustrated in Fig. 15. "Trouble" (fault) proved by a staple in the west back headways, and found to be a 12 foot 6 inch "riser." The incline to rise at 5 inches per yard. The first 14 yards will be shot "open-cast"—that is, as a canch, the thickness of the stone to be removed not being too great. (Beyond a certain thickness it is cheaper and better to "drift" in the "solid.")

Taking height of seam to be 3 feet, 14 yards at 6 inches per yard = 7 feet + 3 feet = 10 feet, ∴ canch averages 5 feet, [illegible]. 5 feet at 3½d. per inch, 5 × 12 = 60 inches at 3½d. = [illegible] per yard. The price for the [illegible]

[illegible] high by 8 feet wide, at a basis price of 13s. 7d. per [illegible] £3 per lineal yard.

14 yards at £1. 3s. 4d. = £17, about
11 yards at £3. 0s. 0d. = 33

Making £50 cost of putting up incline.

Second Example (December 1889).—A short stone-drift to b driven through a "balk," let for 10 yards. The section of the "place was as follows:—

	Ft.	In.
Shale	1	6
Coal	1	6
Seggar (fireclay)	1	0
	4	0

There was a good "parting" at both the top and the bottom of th drift, the size of which was 6 feet by 5 feet. The price paid was 6 per cubic yard—say £1 per lineal yard. The men (who we barely up to the average in skill or strength) made 4s. 9d. a shift.

Of fourteen actual instances of stone-drifts driven at differe collieries in the Northumberland and Durham coalfield, within th last ten to twenty years, the price per lineal yard has varied fro £1. 10s. for a level drift 5 feet wide and 5 feet high, to £6 for drift 5 feet high and 8 feet wide, rising 1 in 6. The average of th fourteen gives 1s. 4d. per square foot area of section: 1s. per squa foot area of section for ordinary coal measure stone is a ra recognised by many.

In driving long drifts through hard stone, considerable econom may be effected by the use of machine rock drills operated b compressed air or by electricity. Fig. 16, Plate IX., illustrates case in point. The drift is 11 feet wide by 6 feet 6 inches hig and has to be driven a distance of about a mile. Two of Cranston machine rock drills are being used, actuated by compressed air at pressure of 55 lbs. per square inch. This is a percussion dri making at normal speed 300 blows a minute, the cutting to being attached to the piston rod, and moving with the sa reciprocating motion. The cylinder is made of gun metal, a [illegible] inches diameter by 5½ inches stroke. The forward fe motion, necessary to keep the machine up to its work as the ho is drilled, and the rotating movement required to be [illegible] the cutting tool, to hinder it striking the same place [illegible] [illegible] communicated by hand through the [illegible]

PLATE IX.

Fig. 16.—Stonemen at work with Machine Rock Drills driven by Compressed Air.

[To face page 92.

grasped by the men, as seen in Fig. 16. These movements may thus be varied at will to suit the varying nature and hardness of the stone, and the mechanism is such that the two movements may be given independently of each other, that is, the machine may be moved forward without rotating the drill, and *vice versa*. The mechanism is strong and simple, and the machine seldom goes wrong or needs repairs. In hard sandstone, holes 2 inches diameter are drilled by this machine 6 feet deep within half an hour, and the rate of progress of the drift runs about 16 yards a fortnight, work being continuous with two men at a time following each other in eight-hour shifts. In softer stone (blue metal and post girdles) the progress has been as much as 25 yards in the fortnight. The men are regular colliery stonemen, and are on "bargain" work. Their price in the hard sandstone is £2 per yard, finding themselves explosives (compressed powder and gelignite). In the softer stone it was 35s. a yard.

(iv.) SINKING STAPLES.—Two examples will suffice.

First Example.—Estimated cost of sinking staple down dip "trouble," to prove the seam (November 1888). Sinking on the slope of the "leader" causes more difficulty than sinking perpendicularly, and as the trouble in this case "haded" very much, it was difficult to cast back the *débris*. The amount of throw of fault was 25 feet; the dimensions of staple, 6 feet by 6 feet.

The ordinary rate of payment would have been 7s. 6d. per cubic yard (= £1. 10s. per running yard), but owing to difficulties introduced by the sloping of the staple, an additional 6d. per cubic yard was paid. The price was therefore £1. 16s. per lineal yard. The character of stone was as follows:—First 2 feet, seggar, or fireclay; next 4 feet, shale; and the remainder, sandstone; but to put against this there was the soft "leader" stone, in which the staple was partially sunk.

Second Example.—The sinking of a staple from the Maudlin to the Hutton seam, for purposes of ventilation (April 1889). The staple was 13 feet 6 inches in diameter, the stone being principally hard shale with some sandstone. No water was given off. The stowage was close to hand, and the *débris* was filled into a kibble, drawn up by a small double-cylindered engine. The price paid per fathom was £11. 6s. = 7s. 2d. per cubic yard. There were six men at the bottom of the staple. Besides sinking the staple, they put in a brattice, and stowed the *débris*.

(v.) MISCELLANEOUS BARGAIN WORK.—The prices actually paid at a large colliery in the county of Durham are given in the following instances:—

(1.) *Drawing chocks in broken or longwall:* 5d. per chock or if done by the shift, 3s. 10d. per shift.

(2.) *Putting through "bord" or "wall-rooms"* (old roads filled up with fallen stone): 5s. per lineal yard, *plus* current county percentage above standard wage.

(3.) *Pillaring in longwall*, which consisted of building pillars 6 feet (and in some instances 8 feet) thick, of refuse stone alongside the gate-ways and cross gate-ways through the goaf. This work was performed by back-bye men,* who were paid on the score of coal drawn out of the particular district where the modified form of longwall was in vogue. Thus, in a particular case: "Pay ending Saturday, 23rd April 1887. 80 score 7 tubs were drawn out of the sixth north way. To J—— C—— & Partners, 80 score 7 tubs at 3s. per score = £12. 1s."

Taking another instance of the same mode of payment, two men will put in 5 yards in two shifts, that is, it will take four men one shift to build 5 yards. 8 × 3.5 × 15 = 420 cubic feet ÷ 27 = 15.5 cubic yards. This at, say, 1s. 6d. per cubic yard = 23.25 shillings ÷ 4 = 5s. 9d. per man per shift.

Again, suppose the walling to be 7 feet thick throughout the gate-ways and the cross gate-ways, and cross pillars to be built every 2½ yards, the pillaring to average about 3 feet 6 inches in height. The men to cut the bottom the full width of the gate-ways and cross gate-ways (that is, to take up what is left by the hewers, who merely cut sufficient bottom stone for tramway width), and to stow the same in the juds. The amount per yard to be paid will be on the following bases—namely, so much per cubic yard for the pillaring, and so much per inch for the canch.

(4.) *Setting timber balks* (long timber about 8 inches square).—This is often paid at so much per balk. If set with props, say 8 feet apart, 1s. 6d. per balk; but if set into the side of way, then 2s. per balk.

(5.) *Underground mason work.*—With arching 9 inches thick, 5 feet wide, and 6 feet high, inside, the following rates of payment were observed in a recent instance:—One mason, at 7s. per yard (he had to pay a labourer out of this); one stoneman (whose duty was to square back the sides, &c.), 8s. per yard: the cost per line yard being thus 15s., not taking into account the cost of "putting the bricks and lime.

---

* Men who do not work in the face.

The following prices were paid in a 6-foot seam. It should b noted that rubble-built stoppings cost more than brick stoppings:—

Brick stopping,	9	inches thick,	at 0s. 9d.	per square yard
"	12	"	at 1s. 0d.	"
"	15	"	at 1s. 3d.	"
"	18	"	at 1s. 4d.	"

Knocking out a stopping, and building up a door in place of i would be paid according to the area of door put in (that is, are taken out), and at the same rate as building stoppings. Plasterin stoppings was paid at the rate of 1¾d. per square yard.

In arching, if the distance between the crown of the arch and th roof was under 1 foot, the masons received no payment for stowing but if the distance exceeded this amount, they were paid at the rat of 1d. per inch for a width of 6 feet (as in canches), or 1s. per cubic yard Masons in all cases stowed the spaces behind the arching and leve with the crown of the arch free of payment. Masons paid their ow labourers. When building *pillars* above arching, masons wer often paid at the rate of 1s. 6d. per cubic yard.

As to "putting" stones, one rule is to pay so much per foot o canch per yard of putting after the first 150 yards, this price bein usually ½d. per foot per yard. For example, canch 1 foot thick, an with a distance on measuring day of 160 yards, the amount payabl over and above the canch price would be 5d.

Datallers.—Under this term are included the various work-men—numbering roughly about one-half of the working miners—who are employed, in addition to the hewers, putters, and stonemen, and who as a rule are paid not by the piece, but by a datal wage.

Shifters are a class of men who do the necessary *repairing and preparatory work* at nights, when the pit is not drawing coals—such as ridding falls of stone and setting timber, to make the pit ready for the following day. They go down in the evening usually at 8.30,* and "ride" (that is, return to the surface) at 4.30 A.M., their shift being

---

The hour varies at different collieries.

eight hours from bank to bank. When working full time during the fortnight, on the pay Friday nights they get a short shift of six hours, for which they are paid the same wage as usual. This is the general custom; but at some collieries they get three short (six hour) shifts in the fortnight—namely, on the two Sunday nights as well as the pay Friday; and sometimes, instead of one six-hour shift, they get two seven-hour shifts in the fortnight, one at each week end.

Wastemen do work similar to that of the shifters, but their work is confined to the return air-ways. They remove stone which has fallen, and see that the roof is properly supported, and that these return air-roads are kept open and of ample size. They are generally old men. Hewers who are too old to hew often become wastemen.

Banksmen and onsetters, instead of a datal wage, are frequently paid a rate per score of coals drawn up the shaft, and thus it becomes their interest to keep the work going, and avoid any stoppages The banksmen are stationed at the landing of the cage on the surface, and their work consists in "uncaging" the tubs—that is taking the full tubs out of the cage, and conveying them to the screens (where this is not done by mechanical power), putting the empty tubs into the cage, and giving the necessary signals to the engineman and to the onsetters. The latter, the onsetters, do similar work at the bottom of the shaft. Fig. 17, Plate X shows onsetters at work. The electric light is now frequently used for lighting the bottom of shafts, and the incandescent lamp covered by reflectors are visible in the photograph.

Rolleywaymen, whose duty it is to keep the way right on the main roads, and expedite the conveyance of the tubs along them are also frequently paid by the score of coals drawn, but more often they are paid a datal wage. They are also the platelayers of the pit and this part of their work is usually paid by the piece at a price per yard, say 1⅞d. for laying new way, and 1d. per yard for taking up the old way. Fig. 18, Plate XI., shows a rolleywayman boring a hole in a sleeper for the pin fastening the rail chair, and a group of fore-shift hewers coming outbye to the shaft at the end of the shift, about 11 A.M. The *locale* is a self-acting inclined plane and the rope and a roller are visible.

There are other classes of underground off-hand labour, varying according to the circumstances of each colliery, such as [illegible]

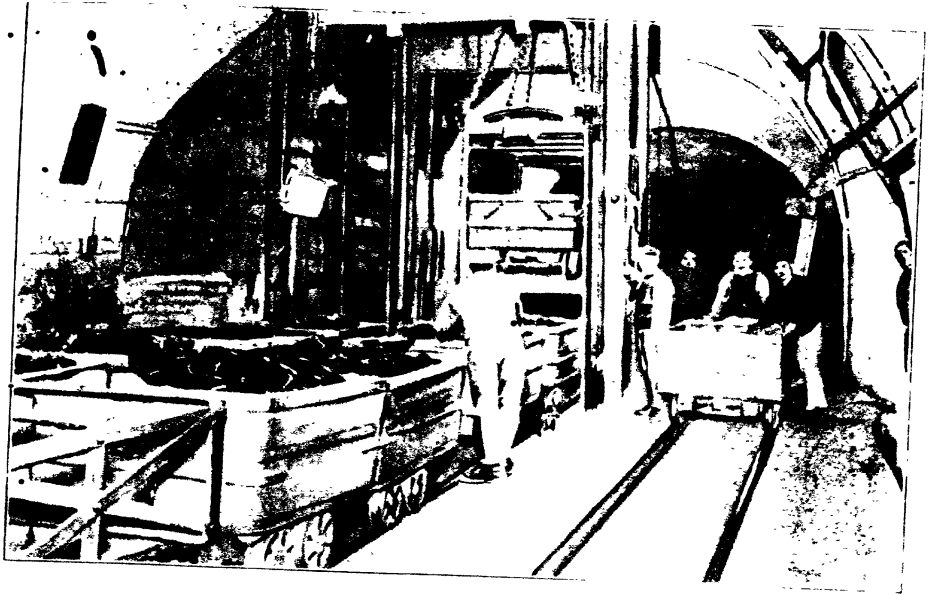


Fig 17 Onsetters at work

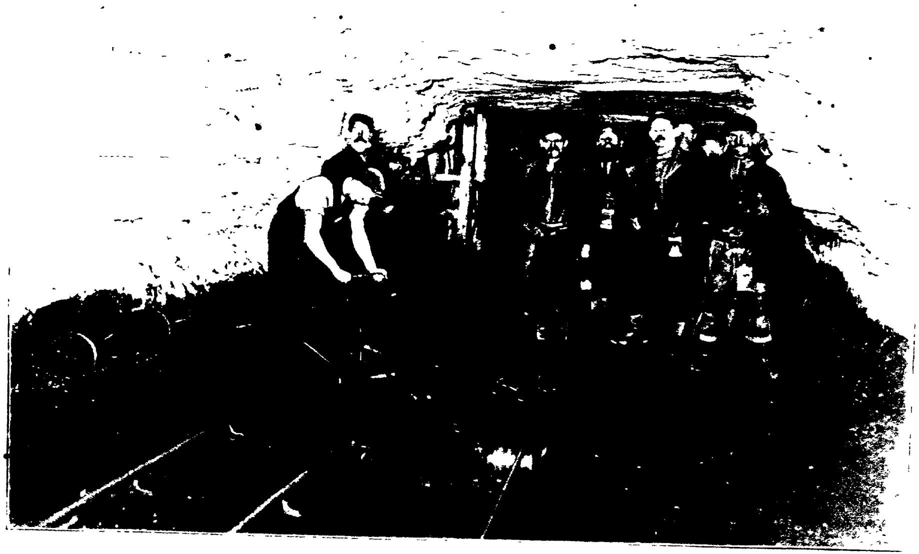


Fig 18 A Rolleywayman Boring a Sleeper, and Fore shift Hewers on their way outbye to the Shaft

[illegible] *Water-leaders, Incline and Engine* *Attendants, Switchkeepers, Couplers, and Trappers,* all of whom are paid a datal wage.

According to the Mines (Prohibition of Child Labour Underground) Act, 1900 (see Appendix to this volume), boys under thirteen years of age may not be employed below ground, and under the Elementary Education Acts they may not be thus employed until they have passed Standard V. in three subjects—writing, reading, and arithmetic—or have made 250 attendances a year at school for five previous years. The latter condition ualifies boys of thirteen years of age, though they have not passed ny standard. By the Coal Mines Regulation Act, 1887, the mployment of a girl or woman of any age below ground in a nine is strictly prohibited. The Act contains several sections ealing in detail with the employment of boys, girls, and women mines, which will be found set out in the Appendix.

The cost of labour per ton of coals drawn will increase as the roportion of off-hand men and boys employed, othe things being qual. In Durham the number of off-hand men and boys, including ermen, deputies, and underground enginemen, is on an average bout 52 per cent. of the total men and boys employed underound, the remaining 48 per cent. being hewers. In Northumbernd the proportion of hewers is rather larger, being 51 per cent.

According to a Parliamentary Return on "Hours of Labour in ines," issued in July 1890, the proportion of off-hand labour is er in Durham than in any other coal-mining district. The lowing Table (which applies to coal mines only, and does not lude metal mines) has been prepared from the figures given in Parliamentary Return:—

District	Men and Boys engaged in getting Coal	All other Underground Workmen.	Percentage Off-hand Men and Boys of total underground	Persons employed on Surface	Percentag Surface Ha of total unc and above ground.
Durham, Westmoreland, and Yorkshire (N. Riding) .	24,178	23,687	49	12,709	21
Durham (part of) included in Newcastle Inspectorate.	8,545	9,767	53	4,817	21
Northumberland ..	11,840	11,226	49	4,648	17
East Scotland	25,548	12,403	33	6,839	15
West Scotland . .	17,884	8,094	31	4,628	15
Yorkshire ...	34,742	21,632	38	12,394	18
Manchester (North and East Lancashire and Ireland)	18,862	9,715	34	5,633	16
Liverpool (West Lancashire, Denbighshire, and Flintshire)	20,124	14,940	42	6,857	16
Midland (Derbyshire, Leicestershire, Nottinghamshire, and Warwickshire)	32,194	16,111	33	12,974	21
North Staffordshire, Cheshire, and Shropshire	11,721	7,235	38	4,728	20
South Staffordshire and Worcestershire	11,145	6,672	38	5,355	22
South - Western (Breconshire, part; Glamorganshire, part; Monmouthshire, Somersetshire, and Gloucestershire)	18,352	10,358	36	4,649	14
*South Wales (Breconshire, part; Carmarthenshire, Glamorganshire, part; and Pembrokeshire)	31,442	23,118	42	9,632	13

* In the case of South Wales the total number of persons employed above and belo ground is given as 73,451. This does not agree with the totals under the separate heads which are stated here as they appear in the Return.

CHAPTER VII.

WAGES BILLS, AND COST SHEETS.

THE fortnightly "pays" in each year, from January to December, are numbered 1 to 26 or 27, in the colliery books and records, so as to facilitate reference and comparison.

The procedure in making up the fortnightly pay bills—which in a large colliery office, concerned it may be with several pits, will in some cases run into thousands of pounds—varies somewhat in details, according to the particular circumstances of individual collieries, and to the differing methods in minor matters preferred by individual managers; but in its main features the general practice is pretty uniform. Of course, in the larger collieries, employing a large and varied staff, a more elaborate system is necessary than the comparatively simple procedure which suffices for a small colliery. In the present chapter a general view is given of what is necessary to be done, and examples are furnished of the various forms of pay bills, returns of produce and cost, and the like documents, required to be used in some shape or other in every well-organised colliery. These examples are taken from various collieries.

The most important of the wage bills is known as the *Overman's Bill*, which includes the wages of all underground workmen. It is necessarily an elaborate document. One side of a large sheet is devoted to a detailed account of the hewers' work, and gives the names of each pair or set of hewers, the number of tubs filled by h[illegible] each day, the total number for the fortnight put into scores or tons, and the amount of money due at the agreed price per core or per ton; also, the yard work and consideration money, and the total gross amount due to each pair or set of men. The number of shifts worked, and the average earnings per shift, are lso stated.

A form of so much of an overman's bill as relates to the hewers is given in Form A, Plate XII.; and the headings of the portion of the same bill relating to the putters, in Form B, in the same Plate. Under these headings are stated the number of tubs put each day by each putter, the total, the prices per score, and amounts due, and the average earnings per shift.

The off-hand men's wages (see *ante*, pages 81 and 96) are grouped together in a separate page, under the various heads of putters, overmanship, deputies, rolleyway, drivers, trappers, engine-plane, braking inclines, &c., horsekeepers, stonemen, and shifters, &c.; but generally a separate wage bill is required for stonemen and shifters, and another for the wastemen.

Another page is occupied by an abstract account (Form C, Plate XIII.), in which the totals already shown are brought forward, and others added, such as onsetting, banking out, "smart money,"—that is, amounts allowed to men and boys injured at their work. From this total some specified deductions are made, on account of coal leading, fines for laid-out, &c. The total thus obtained, if it includes the stone and shift work bill, is the amount spent during the fortnight on labour in getting the coal and bringing it to bank. If the total of the heapkeeper's and mechanics' bills are added to the overman's bill, the grand total will show the cost of all labour for "getting" the coal, and putting it into waggons at the colliery. The cost per score of tubs drawn, and per ton of coals vended, is usually stated on the bill. The quantity of coals drawn each day from the different royalties (that is, the separate areas belonging to different owners to whom royalties for coal worked are payable) into which the workings extend, is also shown, these particulars having to be duly recorded for the making up of the accounts of rents payable to the several owners of the coal properties over which the seams being worked extend. But the headings used for this purpose need not be set out here.*

The cost per score of tubs drawn, and per ton of coals vended, is stated on the bill in some such form as the following:—

---

* At some collieries the overman's bills are kept in book form, which, though it makes them cumbersome to handle, has the advantage of allowing readier reference to back bills.

FORM D.

COLLIERY. TONS DRAWN, COST PER TON, &c.

	Total Scores Drawn.		Days Worked.	Average Scores per Day.		Total Tons Drawn.		Average Tons per Day.		Gross Amount of Bill.			Cost per Score.	Cost per Ton.
	Scores	T.	No.	Scores.	T.	Tons.	C.	Tons.	C.	£	s.	d.	s. d.	s. d.
This Pay.														
Corresponding Pay last year.														
Corresponding Pay of 189 .														

A **Pay Note Book** is usually kept, into which are entered every pay week the names of the workmen employed; their total earnings; the off-takes, under various heads—as, for example, pick-sharpener, priest,* laid-out, set-out, firecoal, water, doctor, miners' permanent relief fund—these items varying at different collieries and with different men; and the net wages, payable direct to the miner, remaining after these deductions. For instances of the particulars required, see Form C, already referred to on the preceding page.

Each set or pair of hewers receives on the Thursday (at some collieries on Wednesday) in pay week—that day being known as "reckoning day"—a *Pay Note* giving the above-mentioned particulars in their case, with the number of shifts worked. A note in the subjoined form is used for this purpose (Form E, page 103). The men come to the overman's office for the note, and can then ask any questions about it, and satisfy themselves that it is correct.

---

* Roman Catholics are found in considerable numbers in most northern mining communities, many of them being Irishmen, and often first-rate workmen; and it is a common practice for them to arrange for the dues to their priest being handed direct to the priest in a lump sum by the colliery officials on the occasion of each fortnightly pay.

At the pay, the pay note book is referred to as each man comes for his money, and the name of the individual to whom the money is handed is written against the amount in the book.

The engineers' and heapkeepers' wage bills, the overman's, the "shift," "waste," and other bills are ready to be examined and checked on the Monday and Tuesday of each pay week; and on these days a manager's time is generally occupied for the most part in examining and passing the wage bills.

A *General Pay Bill* is also made out stating the totals of all the bills, adding incidentals, and deducting any credit accounts which there may be, the form of which will be seen from the following example (Form F, page 104), which is reproduced here on a reduced scale.

Managers generally keep abstracts of labour and other costs, showing the totals and cost per ton under various heads, so that any increase or decrease may be readily noticeable by comparison. These abstracts should show under separate heads all items which are specially variable, such as yard work and "consideration,"* and stone-work. Some such forms as those given in Plate XIV. (Forms G, H, I) are often employed. Form I, which includes in itself some of the details of the overman's bill, is suitable for a small colliery, where from the limited output of coal, and the comparatively small number of men and boys employed, a more elaborate system of account is not deemed desirable.

To show the rise and fall of costs at a glance, graphical methods are most effective. Forms J and K, shown in Plates XV. and XVI., will serve as an illustration of diagrams suitable for this purpose. In one of these, Form J, the varying quantities of coal brought to the surface each fortnight, the quantities sold, and the amounts consumed at the colliery in raising steam and in supplying the workmen with fire coal, are shown, as also are the tons of coke made each pay. In the other, Form K, the varying cost of producing this coal and coke, both for labour and materials employed, is shown in like fashion.

These diagrams illustrate the well-known fact that, roughly speaking, the cost of working varies inversely as the output—that is, if the output of coal is reduced, the cost per ton of getting that reduced quantity will be increased. As the line showing the

---

* There are small payments made to hewers for difficulties and drawbacks in their work of a varying character, the amount being decided at the discretion of the overmen, and coming under the head of "consideration."

FORM E.

COLLIERY. PAY NOTE.

No. *Note.* *No.* *Pay, ending* 190 .

No. of Shifts.	NAME.	Earnings.			Per-centage.		Gross Amount.			OFF-TAKES.												Nett Amount.		
										Rent.	Smith Work.	Priest.	Laid-Out.	Set-Out.	Fire Coal.	Water.	Permanent Fund.	Doctor.		TOTAL.				
		£	s.	d.	s.	d.	£	s	d.											s.	d.	£	s.	d.
																					TOTAL £			

FORM F.

COLLIERY. GENERAL PAY BILL.

PAY No. *From* *to and with* *190*

	Days Worked.	Workings.		Vend.							
				Best.		Unscreened.		Small.		Total.	
		XX.	T.	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.
This Pay -											
Formerly -											
Total -											

Cost per Ton.		£	s	d.	£	s	d.
	Hewing, &c., Seam -						
	Hewing, &c., do. -						
	Shift Work, do. -						
	Shift Work, do. -						
	Waste Work - - -						
	Shaft Work - - -						
	Screening, &c. - -						
	Wright Work - - -						
	Smith Work - - -						
	Mason Work - - -						
	Labourage - - -						
	Keeping Horses, &c. -						
	Draught Work - -						
	Saddlery - - - -						
	INCIDENTALS.						
	Deduct—						
	Cash received for Coals Sold at the Pit this Pay - - -						
	Do. Round Coals T. C. at						
	Do. Small Coals at						
	This Pay - - - -						
	Formerly - - -						
	Total - - -						

AMOUNT OF BILLS AND COST OF WORKING [illegible] (UNDERGROUND). SEAM COLLIERY

		Amount of Bills.					Pit Bill. Costs per Ton.								Cost of Tradesman's Goods.											Average Wage per Shift.								
Names of Seams and Pits.	No. of Pay.	Overman's Bill.	Shift and Shaft.	Waste.	Total.	New Work.	Hewing.	Yards.	Total.	Sundries.		Waste.	Total.		Timber.	Oil.	Grease.	Tubs.	[illegible]	Rails.	Ropes.	Sundries.	Keep of Horses.	Total.	Total.	Hewers.	Deputies.	Rolleyway-men.	Onsetters.	Banksmen.	Brakesmen.	Undergrnd. Brakesmen.	Undergrnd. Firemen.	Putters.
		£ s. d.	£ s. d.	£ s.	£ s. d.	£ s. d. Per Ton.	s.	s.	s.	s.		s.	s.		£ Per Ton.	£ Per Ton.	£	£		£	£	£	£	£	Per Ton.	s.	s.	s.	s.		s.	s.	s.	s.
						A							B												C									

FORM H.

ACCOUNT OF TONS WORKED PIT COLLIERY. COST PER TON, &c. &c.

			Pit Tub.					Tons.												Heaps.					Coals Vended.										Cost of W	
																				Teamed.		Filled													On Workings.	
Names of Seams and Pits.	No. of Pay.	No. of Days worked per Pay.	Best	Bottom.	Total.	Average per Pay.	Average Weight.	Best.	Bottom.	Total.	Average per Day.	Total Number of Hewers [illegible]	[illegible]	[illegible]	Number of Shifts lost per Day.	Average Number of Tons per Shift.	No. of Deputies.	Percentage of Whole Coal worked.	No. of Stonemen, Shifters, and Wastemen.	Best.	Bottom.	Best.	Bottom.	Merchantable Tons.	Best.	Rusty Bottom.	Unscreened.	Nuts.	Small.	Peas and Duff.	Splints.	Coke Ovens.	Total Vend.	% of Vend on Coals Wrought.	Pit Bill.	Total.
			XX T.	XX T.	XX. T.	XX	Cwts. Qrs. Lbs.	Tons. Cwts.	Tons. Cwts.	Tons. Cwts.	Tons									Tons. Cwts.	Tons. Cwts.	Tons. Cwts.	Tons. Cwts.		Tons	Tons	Tons	Tons.	Tons.	Tons.	Tons.	Tons	Tons	%	s. d.	s. d.

FORM I.

							Overman's Bill.																		
																					A	B	A : B		
Names of Seams and Pits.	No. of Pay.	Date ending.	Days Worked per Pay.	Seam.	Output.	Vend.	Hewers' Consideration and Yard Work.	Shift Work and Datal Stone Work.	Bargain Stone Work.	Other [illegible]	Screening and Cleaning.	Total.	Cost per Ton Vended.	Cost per Score Drawn.	Mechanics and Masons.	Rates.	Incidentals.	Credits Deducted.	Total.	Total Cost per Ton Vended.	Hewers' Average.	Tons Hewed per Hewer per Shift.	Cost per Ton of Hewing.	Putters' Average.	Remar
				xx. Tubs.	Tons.	Tons	£ s. d. Per Ton.	£ s. d. Per Ton.	£ s. d. Per Ton.		£ s. d. Per Ton.	£ s. d.			£ s. d. Per Ton.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		s. d.			s. d.	

output rises, the line showing the cost falls. This is due to the fact that there are a large number of charges, commonly termed "upstanding" charges, which continue the same or nearly so, however the output of coal may vary. The water must be pumped, the ventilation must be maintained, the winding engines must be in readiness, the horses and ponies must be fed, the underground roads must be kept good, and a considerable number of men must be employed, even though little or no coal is being got. There are, no doubt, some collieries which may be left almost to themselves without taking harm, but these are quite exceptional. Returns made in this form are, of course, not in substitution of statistical returns in the form of pay and cost sheets, but are made up from these latter to illustrate the course of things over a given period.

Some additional forms are also given—namely, Forms L, M (page 106), Form N (Plate XVII.), Form O (Plate XVIII.), and Form P (page 107)—which have been found suitable in different cases for returns of production, costs, &c., per fortnight or per week. They will sufficiently explain themselves.

It need hardly be said that discretion will have to be used in adapting the examples of forms given in this chapter to the actual circumstances of each colliery for which they are required, with due regard to the fulness of detail desired in each particular case. But in any case the system adopted should be such as to enable the colliery manager to grasp for himself, and make plain for others, the true facts as to each fortnightly working—as regards the amount of coal got, financial results, the cost of its production, &c.—and such as to show readily any waste or extravagance which may occur in any department of labour or in the consumption of materials.

FORM L.

	Colliery.							
	A Seam.		B Seam.		C Seam.		Total.	
TONS DRAWN this Pay								
Do. formerly								
TOTAL TONS this year								
Tons corresponding Pay of last year								
TOTAL TONS last year								
TONS VENDED this Pay								
Added to Heap this Pay								
TONS SALEABLE								
Taken from Heap this Pay								
Total Saleable Tons this Pay ...								
Formerly								
Total this year								
Corresponding Pay last year ...								
Total last year								
Average per Day, Tons								
Average Weight of Tub								
Days Worked								

FORM M.

SEAM.			No. of Hewers on Books.	No. of Shifts Worked per Day.	Shifts Lost per Day.	Off Work per Day per cent.	Tons per Day.	Hewers' Earnings per Day.		Putters' Earnings per Day.		Per cent. of Whole Coal.	Per cent. of Vend on Coals wrought.	Horses.	Train Ponies.	Putting Ponies.	Total.
COLLIERY.	A	This Pay															
		Last Year															
	B	This Pay															
		Last Year															
	C	This Pay															
		Last Year															
Totals and Averages.		This Pay															
		Last Year															

FORM P.

	COLLIERY.			Cost per Ton.		Formerly.			Cost per Ton.		Total this Year.			Cost per Ton.		Cost per Ton last Year.		Co corre pondi Pay i Year	
				Workings.	Saleable.				Workings.	Saleable.				Workings.	Saleable.	Workings.	Saleable.	Workings.	
	£	s.	d.	s/d	s/d	£	s.	d.	s/d	s/d	£	s.	d.	s/d	s/d	s/d	s/d.	s/d	s/
SEAM.																			
Pit Bill																			
Shift & Bargain																			
Waste																			
Shaft																			
Screening																			
Total																			
New Work																			
Total																			
Corresponding Pay of last year																			
Enginemen																			
Enginewrights																			
Joiners, Sawyers, &c.																			
Waggonwrights																			
Joiners at Tubs																			
Smiths																			
Smiths at Tubs																			
Masons, Surface																			
Do. Underground																			
Carting and Labouring																			
Branches & Filling																			
Coke Ovens																			
Stables & Granary																			
Nailor																			
Storehouse																			
Railway																			
Staiths																			
Brickmaking																			
Quarry																			
Gratuities and Pensions																			
Repairing Houses																			
Sundries																			
Salaries																			
New Houses																			
New Work																			
Total																			
Total Labour																			
Total Material																			
Total Labour and Material																			
Total in 18 Labour																			
Total in 18 Material																			
GRAND TOTAL in 18																			

CHAPTER VIII.

TOOLS AND APPLIANCES USED IN COAL-GETTING.

THE pick and the shovel are still the indispensable tools of the miner, as they have been for a good many hundred years. In no department of mining has so little progress been made as in the separation of the coal from its native bed. With the exception of a comparatively small number of collieries, where coal-cutting machinery is being used, and this, *generally*, by way of experiment rather than from the proved assurance of its advantages, coal is now being hewn in much the same way as it was six or seven hundred years ago.

The only advance is in the improved manufacture of the tools, and in the use of explosives for blasting; and whatever may be the engineering or economic advantages of that procedure, from the point of view of safety and health the less explosives are used the better.

Picks are now made of cast steel, and are lighter and more durable than the old iron ones. Coal-hewers' picks vary in weight from 1½ to 3½ lbs., the pick in most ordinary use being 2½ lbs. The lighter picks are used for "nicking," and for the farthest under part of the undercutting or kirving; the heavier picks for breaking down the top coal. A hewer has generally three or four picks with him during his shift. In a soft seam he will not blunt more than one, but in hard coal it may be three or four.[*] A good pick-sharpener is a valuable workman at a colliery. In Durham and Northumberland each hewer pays a fixed sum—usually 2d. or 3d. a fortnight—

---

[*] The life of a pick is of course determined chiefly by the nature of the coal or other strata which it is used to hew. Coal containing lumps of iron pyrites, locally termed "brasses," is very detrimental to the duration of picks, and when hewing in such coal, a hewer will probably use several picks in the course of his shift. On an average taken over a large number (1,000) hewers, the [illegible] of one pick and two pick shafts per annum were found to keep up the [illegible] required per hewer.

to the pick-sharpener, and the owners of the colliery pay [illegible] wage per shift besides.

Fig. 19 shows the ordinary form of coal-miner's pick and [illegible] The shaft is fitted with a steel head, A, slightly tapered, [illegible] made (as shown in the sketch) that it can be sprung out by driving a wooden wedge into the end of the shaft, and can be thus adjusted to fit slightly varying sizes of pick eyes. The pick is fastened tightly on to the shaft by striking the end of the shaft against the ground a few times, and is similarly loosened by striking

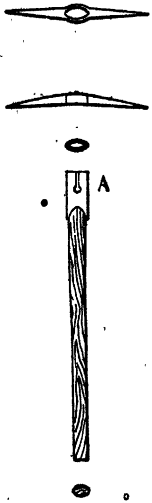


Fig. 19.—Pick and Shaft.

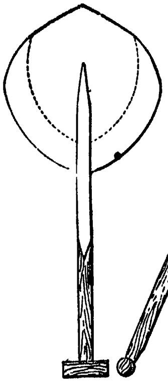


Fig. 20.—Hewer's Coal Shovel.

Fig. 21.—Stemmer.

Miners' Tools. Scale = One-sixteenth.

the other end. Hickory is now generally used for shafts. It is more durable and heavier than ash. A pick shaft of the dimensions shown in Fig. 19 weighs 2½ lbs. Fig. 20 shows an ordinary coal hewer's shovel, made of hammered steel from ⅛ inch to $\frac{3}{16}$ inch thick. With its ash shaft it weighs 8 lbs. Besides his picks and shovel, [illegible] hewer's ordinary working gear includes a mall or hammer and wedge, and where shot-firing is allowed, a drilling machine or set of hand-drills, and a beater or stemmer, a scraper, and a pricker. Where safety fuses are used, or electric wires for shot-firing, pricker is not required. Handy drilling machines weighing

50 lbs.—such as that shown in Fig. 26, and also in Plate VIII.—may be purchased for £1 to £2.

In Durham and Northumberland the hewers provide their own picks and drilling gear, and the owners supply the shovel, mall, and wedge, and also a wooden stool, or "cracket," for the hewer to si upon when working. (In Plate VII., and also in Plate XXII., the hewer's pick, shovel, and cracket are visible.) The Mines Act, 1887, lays it down (General Rule 12), as regards explosives below ground, that "in the process of charging or stemming for blasting, a person shall not use or have in his possession any iron or steel pricker, scraper, charger, tamping rod, or stemmer, nor shall coal or coal dust be used for tamping." In accordance with this requirement, the necessary tools are usually made of an alloy of copper. In the illustrations, Fig. 21 shows a stemmer; Fig. 22 a scraper; and Fig. 23 a pricker. A mall made of 2-inch square iron with steel facings, weighing with its shaft 7½ lbs., is shown in Fig. 24. An iron wedge for breaking down coal is shown in Fig. 25; its weight is 5 lbs.

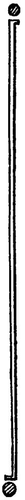


FIG. 22.—SCRAPER.

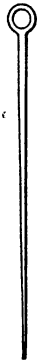


FIG. 23.—PRICKER.

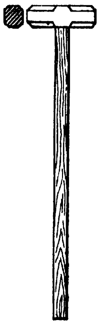


FIG. 24.—MALL.

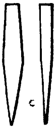


FIG. 25.—WEDGE.

MINERS' TOOLS. Scale = One-sixteenth.

A safe substitute for powder in breaking down coal and stone has long been a great want in coal mining. Many efforts have been made to supply it, by various mechanical contrivances, by the use of lime cartridges (steam, as the expansive or exploding force, being generated by the application of water to the lime), and more recently by the invention of explosive compounds of such a chemical composition that they generate little flame during combustion by detonation.

One of the earliest mechanical contrivances was the stub-and-feather, which consists of a steel wedge or "stub" driven in between two tapered pieces of steel termed "feathers," and placed in the drill hole, thick end foremost. Sometimes the feathers are simply curved pieces of steel with little or no taper. They are made curved in order that they may better fit into the bore-hole. The sizes of "stub-and-feather" wedges vary to suit circumstances, but a convenient length for wedging down coal is about 2 feet 6 inches.

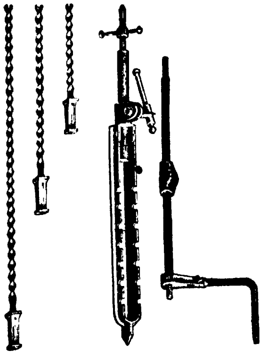


FIG. 26.—HAND-DRILLING MACHINE.

Careful trials with the stub-and-feather in coal getting were made at Elemore colliery, Co. Durham, in 1877. These experiments proved that in pillar working and modified longwall in the Low Main seam—a seam of average hardness, 3 feet 6 inches in section—"juds" 5 to 6 yards in width, well kirved, could be brought down readily by the stub-and-feather when driven consecutively into three drill holes drilled at intervals across the face. Stone-drifts have been driven considerable distances by the aid of the stub-and-feather, where the risk of a gas explosion forbade the use of powder.

For instance, at a colliery in County Durham, in the years 1881-82, a pair of stone-drifts were driven a distance of about 200 yards to win an area of coal, with the help of a MacDermott's drill and stub-and-feather wedge, no explosive being used. A series of holes 2 inches in diameter were first bored close together in a line across the face, at about one-third of the height from the bottom. The stone between the holes was then broken away by driving iron bars into the holes with malls, and a kirving was thus formed across the face. A couple of holes were then drilled, one in the right nook and the other in the left, at about two-thirds of the height from the floor, and the stone above the kirving broken down by driving the stub-and-feather into these holes. The area of drift was 5 feet by 4 feet, and it was driven at a bargain price of £3 a yard (=1s. per cubic foot), all tools being provided by the employers. The rate of progress was very slow. Had powder been admissible, the work could have been done for, at most, one-fourth of this cost.

The stub-and-feather is rarely, if ever, used nowadays, but it embodies the elementary idea of several more recent mechanical contrivances for breaking down coal and stone. The same principle is carried a little further in the multiple-wedge of the Hardy Patent Pick Company, which admits of the insertion of a third wedge. In Jones and Bidder's machine, patented in 1868, a series of wedges (as required) were driven in between side pieces by a small hydraulic ram worked by a hand-pump.* In Burnett's roller-wedge, the friction is much reduced, and the efficiency correspondingly increased, by substituting rolling for sliding friction between the wedge and the side pieces. Mr Burnett also patented a new system of nicking, consisting of a series of drill holes, drilled in the coal at the side of the jud in a line deviating somewhat from the vertical. The Haswell mechanical coal-getter of Mr W. F. Hall, has given good results in some seams.†

The hydraulic principle has been variously applied to the same end, as in the mining wedge introduced by Herr Walcher‡ at some Austrian mines, and subsequently tried at Sandwell Park and other Staffordshire collieries; and in Mr W. S. Shreeve's patent hydraulic wedge, consisting of several hydraulic rams graduated in area, which was tried in the Wigan district. Hydraulic wedges involve, of course the use of water and a hand-pump.

---

* *N. of E. Min. Inst. Trans.*, vol. xix., p. 11. † *Ibid.*, vol. xxxiii.

‡ *Brit. Soc. Min. Stud.*, vol. x. Paper by H. W. Hughes.

These several appliances, as well as others of a similar nature, all appear to have given more or less satisfactory results under certain circumstances, but no one of them has come into general application in any district, and their short-lived notoriety may be taken to signify that they have not fulfilled the requirements of practical work.

Coal-Cutting Machines.—The use of coal-cutting machines has been extending during the last few years, and since the advent of electricity as a motive power increased attention has been paid to them. Future progress in development of the means for the getting of coal would appear to lie in this direction.

To one acquainted with the achievements of mechanical science in devising machines for saving of labour, it is certainly surprising that the laborious work of undercutting or "kirving" coal seams is still being done by manual labour. That this is so, is not for lack of inventive endeavour on the part of mechanical and mining engineers. In 1761 a machine for cutting coal was patented by Michael Menzies, of Newcastle, and since then scores of machines have been devised, and repeated attempts made to utilise them in practice.

The application of compressed air to underground work gave them a fresh start, and early in the sixties coal-cutting machines, driven by compresed air, were being carefully tried at Durham and Yorkshire collieries and elsewhere. In some cases they have been successful beyond doubt. By their aid, thin and hard seams have been got, which could not have been worked to profit by hand labour—as at Lidgett colliery, where the weekly output was increased from 700 to 2,000 tons, and the working cost reduced 1s. per ton by the adoption of coal-cutting machines.*

Stronger and better constructed machines have been introduced within the last ten years, 1896-1905, and their use is extending rapidly. But it should be borne in mind that the local circumstances of particular mines even in the same district are often so dissimilar, that a machine which gives valuable results in one case may be of little or no benefit in another.

Favourable conditions for the use of machines are (1) a strong roof; (2) freedom from faults or other geological disturbances; and (3) an even floor. There are machines working satisfactorily in seams lying at an inclination of 1 in 4 to 1 in 6½, but

---

c. *Min. Stud.*, vol. x. p. 124. Paper by R. W. Clarke.

variations or irregularities of gradient are very disadvantageous to the use of machines. Much depends on the care and skill and energy of the men employed with them, and on the official in charge.

Absence of gas to a dangerous extent is also essential where the ordinary direct current electro-motor is employed as the agent to drive the machines.

In gassy seams electricity may be used for transmitting power along the main roads, and for driving air compressors placed by the side of the main intake as near the face as practicable, the compressed air being used for driving machines in the face. This is now being done at a good many collieries, and in one instance at least, known to the authors, the efficiency of the combination is considerably higher than that usually obtained from a compressed air plant throughout.

An important consideration is the physical characteristics or structure of the seam where the machine is used. Sometimes the coal falls as soon as it is undercut, and clogs the cutter, causing difficulty and delay. This may sometimes be remedied by altering the direction in which the face is advancing, carrying it across the main cleavage planes instead of parallel to them.

All the coal-cutting machines at present in work may be classed under five heads:—

(1.) The *Percussion* type, in which the guiding idea of the designer has been to reproduce mechanically the action of the hewer's pick upon the coal—for example, the Ingersoll-Sergeant (see Figs. 29, 30, 30A), the Champion (see Figs. 30B, 30D), and the Little Hardy (see Fig. 30C).

(2.) The *Disc or side-wheel* type, in which the cutting teeth are attached to a revolving wheel, such as the Diamond (see Fig. 32A), the Gillott & Copley (see Fig. 31), and others, which are suitable for long straight faces, as in longwall working, but are inapplicable to narrow work.

(3.) The *Bar* type, in which the cutters are fixed in a rotating bar or shaft, such as the Hurd bar machine (see Fig. 33).

(4.) *Chain machines*, such as the Jeffrey chain header, and, for longwall faces, the Morgan-Gardner and Mather & Platt. The cutters are attached to a revolving chain (see Fig. 27) in place of a round bar or a disc.

(5.) The *Rotary* type, of which the Stanley header is the representative, which cut an annular groove in the face of the heading.

For a long time compressed air was principally used as the driving power for machines of the side-wheel type. As the wheel revolves at a comparatively slow speed, some difficulty was ex-

perienced in adapting such machines for driving by an electro-motor. This was first achieved by Messrs Clarke & Steavenson at

Lidgett colliery, near Barnsley. At no colliery has coal cutting by machines been attended by more satisfactory results. Experience here has served to show the considerable advantage of cables as a means of conveying power from the surface to the coal face in comparison with the pipes required for compressed air. A daily output of about 450 tons is obtained from eight machines, working in a seam of the following section (taken in the face on the occasion of a visit):—

	Feet.	Inch.	Foot.	Inches.	
Coal	2	1			Good house coal, known as Flockton Wallsend.
Stone band			0	3	
Worthless coal ...			0	10	Cast back into the gob.
	2	1 +	1	1 = 3 feet 2 inches.	

The holing is done in the band, and the 10 inches below this is of great service in affording room for the *débris* from the cutting, which is brought out of the cut by the cutting wheel as it revolves, and which, when it cannot be got out of the way, is apt to clog the movement of the wheel. The machine is raised to the necessary height by using wooden sleepers of the suitable thickness below the rails.

There are several longwall faces in this seam, kept as straight as possible, varying in length from about 100 to 500 yards. Gateways are made at intervals of 1 chain, and cross gateways at about 50 to 60 yards. Each machine is assigned to one face. It undercuts the whole length of face, and is then taken along the cross gateway, being pushed along the rails by manual labour to the other end of the face, where it starts again to undercut.

In the case of the electric machines, the conducting cables are laid along the cross-gates, being fastened to the props by stoneware insulators, and are carried from the cross-gates up every other gateway. Thus 20 yards length of cables are required in the face to feed the machine while undercutting a length of about 40 yards of face.

The cables thus employed consist of seven copper wires of No. 16 S.W.G., covered with rubber and an outside coating of hemp. The top stone sometimes falls heavily in the face, entirely covering the machines, but the cables have never yet been cut through. Safety-lamps are used, but the amount of gas is very small. The current driving the motor has a tension of about 400 volts. The motor makes 1,000 revolutions a minute, normal speed, and this speed is brought down through toothed wheel gearing to a rate

PLATE XIX.

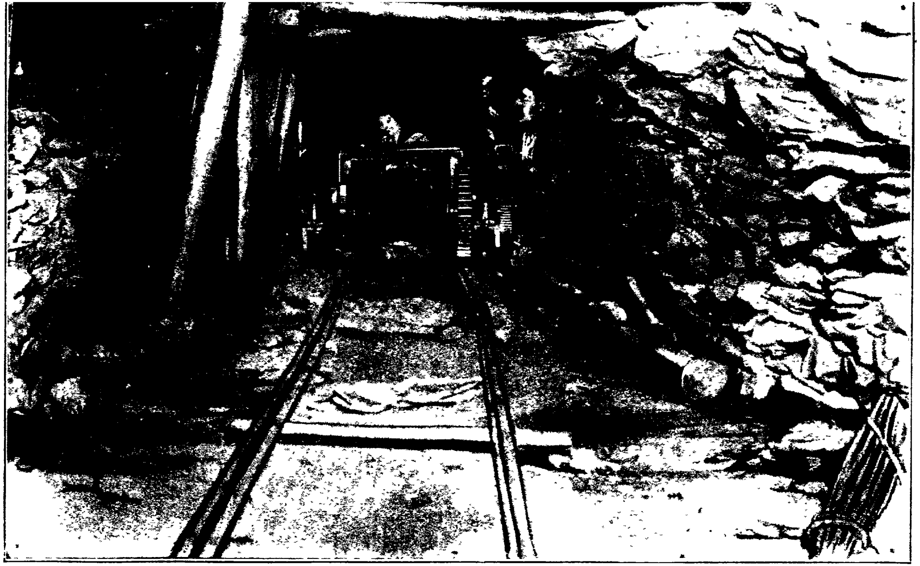


Fig. 28.—Messrs Clarke and Steavenson's Electrical Coal-Cutter at Lidgett Colliery.

[*To face page* 116.

of 30 revolutions for the cutting wheel on the fourth motion.* This wheel is 4 feet in diameter, and carries twenty cutting teeth, ten single and ten double, placed alternately, made of the best steel procurable. The cut is 3 feet 6 inches under and $3\frac{1}{2}$ inches in height. There are two switches, one for turning on and off the full current, and the other for regulating it by bringing into circuit resistance coils. It is under the full control of the attendant, so that the cutting wheel can be started and stopped again within a few inches of its movement, which it is sometimes necessary to do when changing the cutting teeth at the coal face. The switches and motor are enclosed and protected by a steel cover enveloping them, and when necessary this cover can be made gas-tight.

The machine is made of steel throughout, and the various parts are in duplicate, and when needing repairs are taken out and replaced underground, thus saving the time and trouble of taking it to the surface.

The dimensions over all are—Height, 22 inches from the rail; length, nearly 9 feet; width required to work in, 3 feet 9 inches; gauge of way, 21 inches. On an average, allowing for stoppages and time occupied in moving the machine, the useful work done amounts to 60 yards length of face in a shift of eight hours, or 78 square feet per hour. As a rule, the machine will "hole" to a depth of 3 feet 6 inches in the stone band, a longwall face 210 yards long, within three eight-hour shifts. When going straight ahead in the face without any untoward circumstances, it will cut a yard [illegible] minute.

The photograph reproduced in Fig. 28, Plate XIX., which was taken by one of the authors during a visit to Lidgett colliery, represents one of these machines in the act of "flitting"—that is being taken along the cross-gate from one end of the longwall face to the other. The cutting wheel has to be detached and conveyed separately.

It is now, however, becoming more usual to employ a machine to cut in both directions along the face, so as to save the labour of "flitting."

With side-wheel cutters and all others, except those of the Ingersoll type, it should not be overlooked that the coal got in the cutting (where this is made in the coal and not in stone) is practically lost. Mr R. M. Haseltine, a Chief Inspector of Mines in the United States of America, who has published the results of some valuable experiments on coal-cutters, gives the following figures as the average proportion of produce:—

---

* In the compressed air machines the ratio of gearing is about [illegible] the engines going at 150 revolutions, and the cutter wheel on the third [illegible] 30 revolutions.

Lbs.	With Machine.	With Pick—Hand Holing.	Lbs.
2,000	Lump coal, 72 per cent. ...	... 66 per cent.	2,000
347	Nut " 12½ " ...	... 14 "	424
42	Pea " 1½ " ...	... 6 "	182
389	Slack " 14 " ...	... 14 "	424
2,778			3,030

That is, for every 2,000 lbs. round coal, 778 lbs. of small coal are produced at the same time by the machine; and by hand holing with the pick, 1,030 lbs. of small, or 252 lbs. more. With machines of the Ingersoll type, the results in this respect are practically the same as with pick mining, the form of undercutting being the same—that is, considerably higher in front than at the back.

Alternating current electricity with a three-phase motor is now applied successfully to driving longwall machines of the disc and bar and chain types. Some of the advantages of triphase induction motors are (1) the absence of commutator and brushes, hence requiring less attention, and eliminating the danger of sparking in a gaseous mine; and (2) when the work to be done is beyond the power of the motor, it simply stops, whereas a continuous current motor goes on till something breaks.

The following figures, which give the results of a series of trials with two machines of the percussion type—namely, Harrison's and Firth's—in September 1865, are of interest as showing what was being done forty years ago:—

	Harrison's Machine.	Firth's Machine.
Time worked in minutes	148	156
Length cut in yards...	24.5	31.5
Depth cut in feet and inches	2.8	2.8
Square yards cut	21.77	31.18
Minutes per square yards	6.81	5.00
Square yards per hour	8.82	12.00
Strokes of air engine	33.15	21.71
Pressure of air at engine in lbs.	31.41	29.65
Do. do. at cutter in lbs.	25.5	28.5

Mr William Firth, whose pick-machine has been in use for more than thirty years at the West Ardsley collieries, near Leeds, stated in a paper read before the British Association in 1873, as the resul of his experience, that forty-eight persons with the machine woul get as much coal as sixty men hewing by hand, and that on a dail output of 60 tons there would be a saving of 1s. 7d. a ton. At tha time, when wages were very high, the cost of putting coals int tubs by hand labour was 4s. 5¾d., and by machine 2s. 10½d., per ton including 1d. for maintenance, and 2d. for redemption of capital.

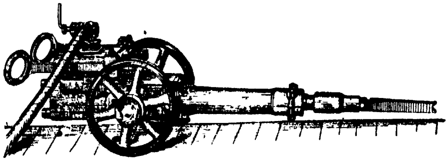


FIG. 29.—INGERSOLL-SERGEANT COAL-CUTTER.

Perhaps the best known of the percussion type of machine i the Ingersoll-Sergeant, an American invention, which is doing goo work on both sides of the Atlantic. It consists of a cutting tool o drill connected with a piston which is driven to and fro by compressed air. It has the merit of being simple, strong, and ligh and occupying small space; and it allows, better than any other typ of machine, of the combination of mechanical power with huma control. More depends on the man controlling it. Fig. 29 gives general view of it, and Fig. 30 shows it in section. The machin illustrated is 7 feet long, and 15 inches high, the cylinder being inches in diameter by 8 inches long. The speed can be regulate by means of the two screws A, A. B is a cushion at the back of th cylinder, consisting of a ring of indiarubber and a metal plat The cushion at the other end is formed by the thick leather wash

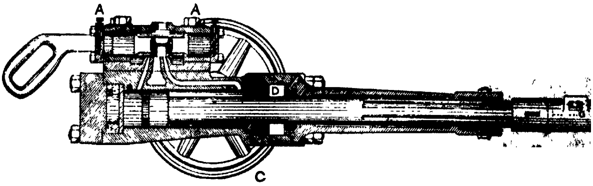


FIG. 30.—INGERSOLL-SERGEANT COAL-CUTTER.

C, and the air space D, which is in constant communication with the main air supply.

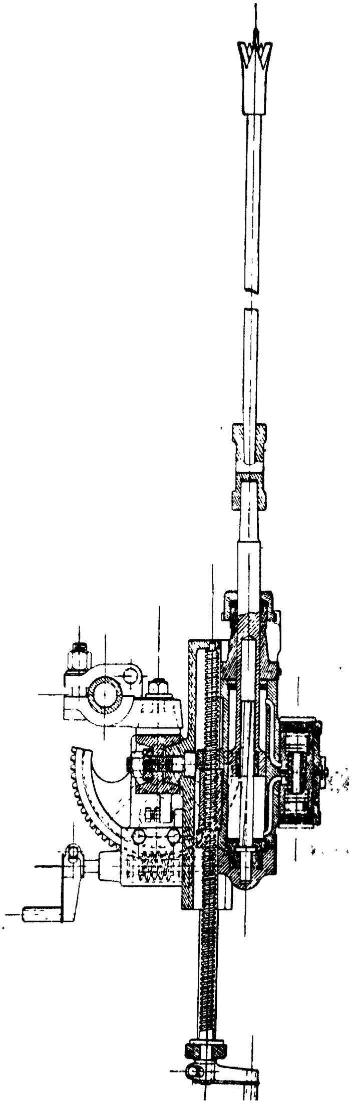
In the newer machines these indiarubber and leather cushions have been replaced with advantage by cushions of air, the compressed air being admitted at each end of the cylinder before the piston completes its stroke. The wheels are 14 to 20 inches in diameter, varying in size to suit the seam. When the machine is used for nicking or shearing, larger wheels are required, and are substituted for the smaller ones. The cutting tools (or picks, as they are sometimes called, though they are more like drills than picks) are fastened to the piston rod by the key G. They are made of forged steel, one side being flat and the other bevelled, so that they act as wedges as well as cutting tools. They are made of various sizes. To work the machine, a man sits astride of it, holding it by the handles, and with one foot armed with a wooden clog set against one wheel of the machine, and directing the blows as he likes. These machines are especially suited to bord and wall or pillar and stall working. A place 8 feet wide can be kirved across the full width and 4 feet under in about an hour. The kirving is made about 8 to 15 inches high in front, tapering to *nil* at the back.

FIG. 30A.—INGERSOLL RADIAL MACHINE.

Though the Ingersoll has the merit of allowing great freedom of control to the man holding it, yet this entails the drawback of a considerable jarring action which he has to withstand. And it is not suited to places less than 3 feet 6 inches in height, nor to rise headings, nor to kirving in a band occurring at some height in a seam. To meet these requirements percussive machines attached to a vertical column or to a frame fixed to the floor are being increasingly used, *e.g.*, the Champion (or Siskol) and the Little Hardy.

The Ingersoll Company have recently introduced a machine attached to a vertical column — the Ingersoll Radial, which is shown in Fig. 30A. A wheeled carriage has been designed also for this machine by Messrs C. F. Bouchier & Young (patent dated 10th November 1904). It is in use at Messrs Crompton & Shawcross Limited collieries in Lancashire, and is preferred to the ordinary Ingersoll on wheels.

The Champion is a strong machine well



adapted to hard holing. It has a toothed sector and worms (see Fig. 30B), through which the movement to right and left is given to it when holing, or up and down when nicking. This steadies it and keeps the holing regular.

The Little Hardy (shown in Fig. 30C) is the most recent, and has the advantage of being the lightest and the most handy of coal-cutting machines, and therefore well adapted for thin seams. The machine, type A, with 1 foot cutter weighs 150 lbs., and the column 4 feet long 45 lbs. A stronger machine, type B, is also made, not weighing much more, and better adapted to hard holing.

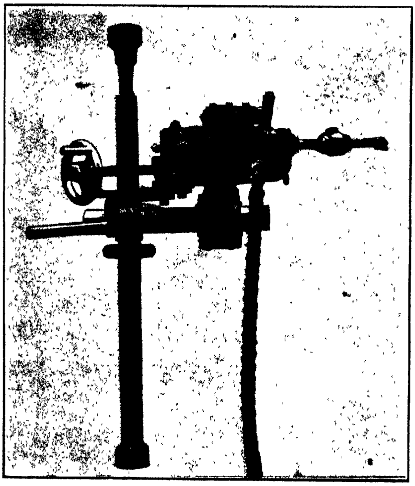


FIG. 30C.—THE LITTLE HARDY COAL-CUTTER FIXED FOR HOLING BETWEEN FLOOR AND ROOF.

In this class of machine—namely, the Champion and the Little Hardy—the machine is so attached to its standard that it can be moved round it whilst delivering its blows on the coal face (see Fig. 30D, illustrating the Champion coal-cutter). The attendant moves it round the column as a pivot from right to left or left to right as the cutting proceeds, so that in plan the cutting takes the form of the segment of a circle, and to square up the corners longer drills are used and the blows directed into the corners. It makes a narrow uniform cut about 3 inches thick. The depth of cut depends, of course, on the length of drills used, and may be extended to 12 feet, but half this is usually sufficient. It will cut a any height in the seam, according to the height at which th machine is clamped to its column, and at any angle of rise or di It is fed forward by a screw and handle moved by the driver as th cut deepens, the length of screw being about 2 feet. The drill i automatically rotated after each blow.

The special feature of the Little Hardy is its circular valv which enables it to be driven at the high speed of 600 to 700 blow a minute, with air at 60 lbs. pressure, or at 45 lbs. 450 to 500 blow It is adapted for "nicking" in thin seams and for drilling shot hole as well as for kirving. At a Yorkshire colliery one of the auth

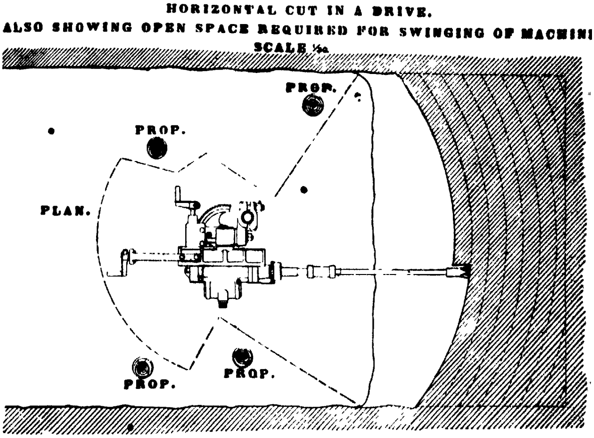

HORIZONTAL CUT IN A DRIVE.
ALSO SHOWING OPEN SPACE REQUIRED FOR SWINGING OF MACHIN
SCALE 1/40
PROP.
PROP.
PLAN.
PROP.
PROP.

FIG. 30D.—THE CHAMPION COAL-CUTTER.

saw it doing good work in driving the advance headings or "stables at the ends of a longwall face undercut by disc machines in a 2 foo 4 inch seam. These stables are driven 9 feet wide and are under cut by the Little Hardy to a depth of 9 feet in a bed of hard segga below the coal, and also "nicked" at one side in the coal to a dept of 9 feet.

Two men are employed with the machine, and they are paid a the rate of 1s. 1⅛d. per square yard of cutting. Thus the kirvin and nicking of this 9-feet heading to a depth of 9 feet costs 12s. 9 (net). The men usually accomplish this in an eight hours' shi earning very good wages.

	s.	d.
The yield of coal for this cutting is 6 tons 15 cwt., making the cost per ton of the machine labour	1	10.66
Getting and filling the coal, taking up bottom to make a height of 3 feet, timbering, laying way, and putting the tubs to the siding on the gate road costs per ton	1	9.62
Total cost per ton	3	8.28
When this work was done by hand the actual cost over a considerable period amounted to	5	2.53
Showing a saving per ton in favour of the machine of ...	1	6.25

From this has to be deducted the cost of the power (compressed air) of maintenance, and of plant and depreciation, which usually runs from 3d. to 6d. a ton. With the aid of the machine the headings are driven half as fast again as by hand.

The side-wheel type of machine is the one which has been most generally adopted as yet in England, Gillott & Copley's—which has been in active operation for forty years—being one of the best known. It is shown in Fig. 31.

In an application of this machine at Altofts colliery, near Leeds, in a seam 3 feet 10 inches thick, with 10 inches of inferior unmerchantable coal below, in which the holing was made, considerable advantage was gained by increasing the depth of the cut from 3½ to 4½ feet, and the height from 3½ inches to 4½ inches, the extra height enabling the wheel to clear itself better. A cutting wheel 68 inches diameter was used. Less than half the number of blasting shots were required in the same length of face, and by still further increasing the depth of the cut to 5½ feet, it was hoped to do away with shot firing altogether.

By the aid of these machines it is stated* that 120 men are able to do the same amount of work as 172 men did previously.

The machine is propelled along the face (in the way still practised with all side-wheel machines) by a small wire rope carried along a considerable length of face to a pulley block fastened to a prop or screw-jack at the far end, from which it returns to the machine, and is slowly coiled on a drum made to revolve by the machine, the speed being regulated according to the nature of the material to be cut.

The use of "skids" or "sledges" for the machine to travel on along the face in place of wheels and rails is becoming increasingly common. There is a heavy outward thrust on a machine undercutting a longwall face, and it is necessary to counteract this thrust in order to keep the machine up to its work. This is done when the machine is on skids by means of one or more steel blades (like ploughs), which are attached to one side of the frame of the machine and which cut into the floor. Where rails are used it is most important that they should be firmly laid, so as not to be displaced by the strain of the working of the machine. The usua procedure is to have three lengths of rails, and as the machine clears one length in its onward passage, it is taken up and handed to a man at the other side of the machine, and there relaid by him. This entails a large amount of labour, and where "skids" can be

---

* *Trans. Fed. Inst.* vol. vii. p. 149. T. H. Wordsworth.

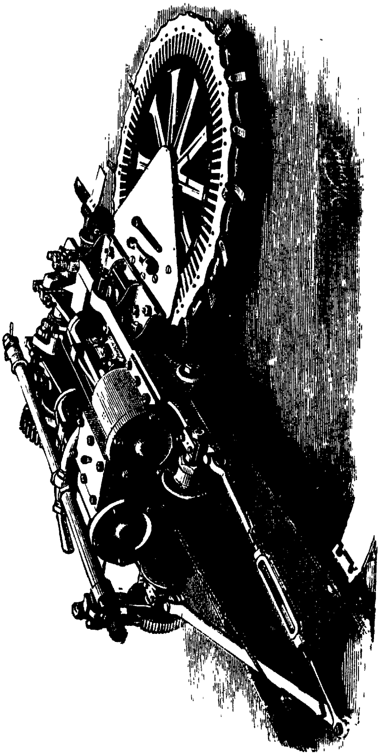


FIG. 31.—GILLOTT & COPLEY'S COAL-CUTTER.

used instead of rails, one man's labour may be saved. In some instances the cutting is made slightly inclined, as shown in the section, Fig. 32. This saves the taking up of a certain amount of bottom stone or seggar, marked *a a a*, which comes away with the coal when it is taken down by the hewers. The portions marked *b b b* do not require to be taken up, being necessary to maintain the slanting position of the machine.

The arrangement of the working faces of coal is an important point in the successful application of these side-wheel machines. At a colliery in Yorkshire, the system followed is to open out a couple of straight parallel faces by driving a heading 6 feet wide the desired distance. The machine then starts along one face and returns by the other. The goaf, or exhausted space, between the faces is thus being constantly enlarged. The ideal state of things is that the machine should be continually employed in cutting coal, without requiring to be moved from one place to another.

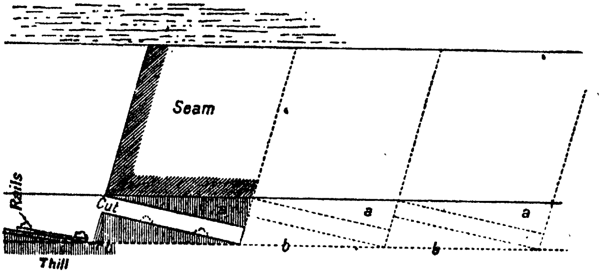


FIG. 32.—SECTION SHOWING INCLINED UNDERCUTTING.

A well-known disc machine which has come to the front recently is the Diamond (Fig. 32A), perhaps the strongest of the disc machines and better adapted than most to hard cutting. In it the air cylinders, where air is used as the motive power, are placed not side by side but one at each end of the machine, with the bevel wheel gear and the disc between them, and similarly in the electrical machines two motors are used, one at each end of the machine.

It is significant of the trend of experience that the motors for electrical coal-cutters are now made of 20 to 30 H.P., just about double the power that they used to be as first applied to these machines some fourteen years ago.

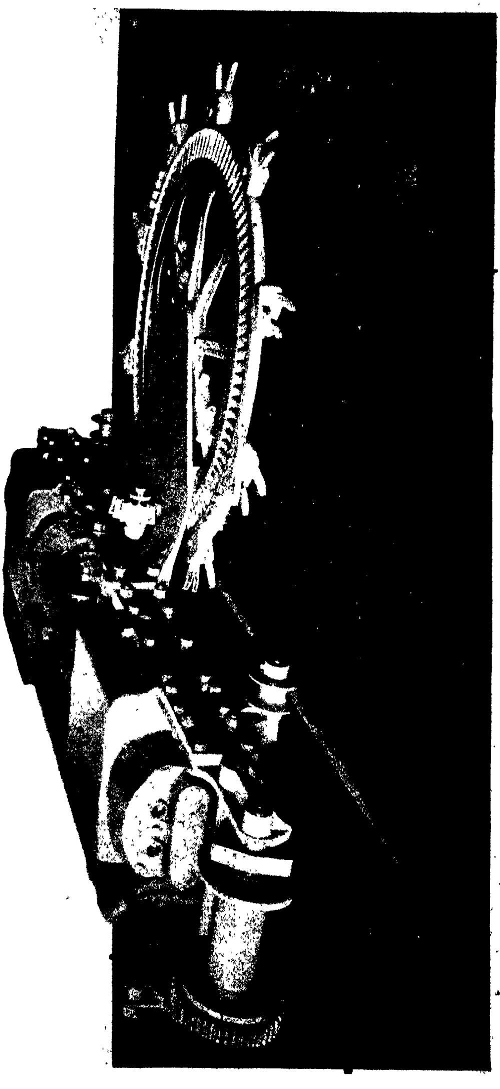


Fig. 32a.—The Diamond Coal-Cutter.

In the Diamond machine (Fig. 32A) the cutters are fixed in boxes, three to a box, and the box is fastened to the rim of the disc by a bolt. A disc undercutting 4 feet to 5 feet carries ten boxes or thirty cutters. It is of strong construction, and allows of ready change of the cutters. The renewal of cutters is an important matter in mechanical coal-cutting, occupying as it often does twenty minutes or half-an-hour, and requiring to be done frequently when cutting in hard material.

In comparison with a disc a bar has certain advantages. It occupies less room and is not liable to be jammed by coal falling on it, which is not an uncommon occurrence with discs. It allows of the insertion of sprags to support the undercut coal close behind the advancing cut, whereas with discs the whole diameter of the disc must intervene. A bar will cut its way into the face, and can be swung out of the cut or into it in a horizontal plane.

In the Hurd bar machine (Fig. 33) this horizontal movement of the bar can be extended through 180°, and there is a similar extent of vertical movement; the gear box and bar may be turned round vertically through an arc of 180°. The bar makes a tapered form of cut, about 7 inches high in front tapering to a line at the back. This cuts away more stuff than a disc, which may be desirable where there is a thick "band" to cut in, and the tapered form may assist the subsequent getting of the undercut coal. A parallel form of bar is preferred in some instances to the tapered form.*

In the Hurd machine the bar not only rotates but has a to-and-fro movement of about 2 inches in and out of the cut. This helps the cutting action and hinders clogging. On the other hand, a bar does not clear out the *débris* from the cut like a disc; it is not so well adapted for cutting in both directions along the face; and it will not cut on the floor level like a disc. An endless chain is lighter and less bulky than either a bar or a disc, and appears to afford the best method for carrying the cutters.

The Jeffrey chain header is doing good work, as described hereinafter, but as yet the endless chain machines constructed for longwall work hardly seem to be strong enough.

Some interesting experiments recently made by Mr R. M. Haseltine, Chief Inspector of Mines in America (already referred to at page 118), bring out the decrease in the power required by chain heading machines as compared with those of the bar type.

---

* See *Trans. Fed. Inst. M.E.* vol. xxvi. p. 256, paper on "Electric Coal-Cutting," by W. Walker.

Five bar machines and seven chain machines were tested, whilst working at seven collieries situated at various points in the State of Ohio. Electricity was in all cases the motive power. Whilst the bar machines consumed on an average 18.7 H.P., the chain machines required only 14.4 H.P. to do practically the same work. To overcome the frictional resistance of the machine (apart from cutting the coal), the bar machines required on an average 6.85 H.P., and the chain machines only 4.22 H.P.

The Jeffrey header, first introduced in the U.S.A. about 1876, was made with a rotating bar and driven by compressed air. In 1889 an electric motor replaced the air cylinders, and in 1894 an endless chain was substituted for the bar. The superior efficiency of the endless chain has been so clearly shown that the bar has quite gone out of use for heading work.

In the Jeffrey chain header the chain carrying the cutters is in the form of an isosceles triangle, at the apex of which is a sprocket wheel giving motion to it, and at the angles of the base two small wheels round which it turns.

The chain with the motor or air cylinders is carried on a frame which is moved forward and backward—in and out from the coal face—by the aid of pinions gearing into a rack on a fixed underframe, securely stayed both in front and behind.

As shown in Fig. 34, the chain is inside the stationary frame, and runs in a guide, which prevents undue vibration or side motion. The chain belt travels on a horizontal plane, so that only the cutters in front of the cutter head attack the coal. The electro-magnets of the motor form an air-tight and dust-proof case for the working parts of the motor. Access is obtained to the commutator and brushes by raising a lid in the top of the motor casing, and this lid is itself part of the magnetic circuit, so that when the machine is at work the lid is held down tightly by the magnetism of the field.

The dimensions, &c., of an air-driven machine run as follows:—Length over all, 10 feet 6 inches; width across cylinders, 3 feet 6 inches; height, 1 foot 10 inches; weight, about 25 cwt.; two cylinders, each 6 inches diameter by 5 inches stroke; sprocket wheel on third motion at a ratio of 1 to 30 of engine shaft; length of chain 20 feet, carries forty-six cutters.

Those of the *low type* (see Fig. 34), electric driven, are in height 21 inches, length 10 feet 3 inches, width 3 feet 2 inches, weight 27 cwts.

Machines are built to undercut to depths of 5, 6, and 7 feet, the width being either 3 feet 3 inches or 3 feet 8 inches, and the thick-

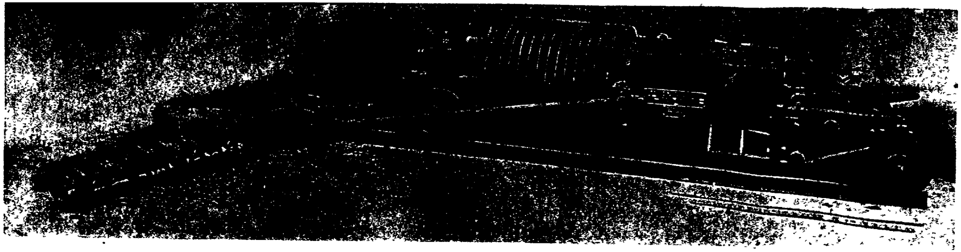


FIG. 33.—HURD COAL-CUTTING MACHINE, WITH ALTERNATING CURRENT ELECTRIC MOTOR ADJUSTED FOR UNDERCUTTING.

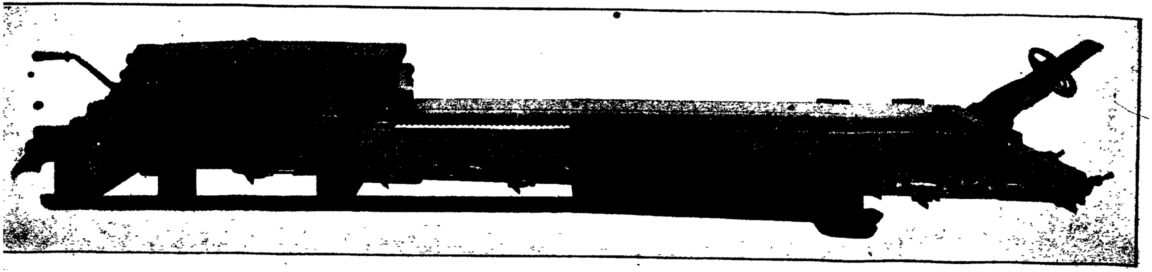


FIG. 34.—JEFFREY CHAIN COAL-CUTTING MACHINE, WITH INCLOSED MOTOR AND INCLOSED STARTING SWITCH.

ness of cut 4¼ inches. The undercut is made in both direction across a heading from right nook to left nook, and back from lef to right, but the cutter chain always revolves in the same direction from right to left. Therefore, when the machine is going from left to right the cuttings are deposited largely in the space made by the previous cut and need scraping out with a rake.

Three men are usually employed with it. Its size and weight handicap it in comparison with the percussive machines. In undercutting a place 12 yards wide it requires moving and resetting eleven times, and the timber also must be moved. It is not suited for steep seams. On the other hand, in speed of undercutting it is more efficient than the percussive machines, and it consumes less power. It has been in use for several years at South Hetton colliery, Co. Durham, and here several improvements have been added to it, to enable it to be moved about more easily, and to adapt it to drilling holes in the coal face besides undercutting. These appliances are described in the Report, Part II., "Heading Machines," of the North of England Mining Institute, issued in November 1905.

When at work in the coal face these machines are placed on wooden skids—of the dimensions, say, of 12 feet by 6 inches by 4 inches—with a piece of ½-inch round iron let into the centre of their upper surface for the machine to slide on when being moved from one position to another. These skids lie on the floor in a direction parallel to the face.

An ordinary performance of this machine is to undercut a stall 15 yards wide in an eight hours' shift—bank to bank—to a depth of about 6 feet, cutting in a hard shale band in a seam of the following section:—

Coal	2 feet 0 inches			
Shale band ...			0 feet 7 inches	
Coal with bands	1 foot 6 inches			
	3 feet 6 inches	+	0 feet 7 inches	= 4 feet 1 inch.

As the level of the cut is about 2 feet above the floor, the machine is raised to the desired height on metal bearers fixed underneath to the sides of its frame. In cutting the width of 15 yards the machine has to be moved fourteen times. The pressure of air at the machine runs about 45 lbs. The ordinary rate of undercutting, including all stops, is 31 square feet an hour, and this is in hard material.

With the aid of this machine a heading 9 feet wide has been driven in this seam at the rate of 30 yards a fortnight, and at a very considerable reduction in the cost per ton. Both the coal and the band are hard, and with hand holing the rate of progress would not be more than 10 yards a fortnight.

As regards the proportion of round coal made, there are some seams where the coal requires to be shot down in headings after being undercut, the narrow slot-like cut made by the chain header being sometimes insufficient for the fall of the coal. Where "shots" are required the proportion of large coal will be reduced. This machine is not adapted to "nicking" (vertical cutting).

In driving headings with it in some seams, the proportion of round coal got is less than with hand holing, more small being made. But this is not always so. It depends on the structure of the seam, and the direction in which the place is advancing. In some cases a considerably larger proportion of round coal is got than with hand holing. But in this respect the machines of the Ingersoll type have the advantage.

The experience gained in the United States throws some light on the relative merits of these machines. Within recent years, the number of electrically-driven chain machines in use there has been increasing much faster than those of the percussive air-driven type. This, however, may be due to the increasing use of electricity as a motive power as well as to the greater efficiency of the chain machines.

The recognised scale of payment of labour is lower with the chain than with the percussive machines. According to the Pittsburg mining scale, which was given in evidence before our recent Coal Commission by Mr A. S. E. Ackerman, the cost per ton agreed to by owners and workmen is 38 per cent. less for labour in cutting with the chain machine than with the percussive. On the other hand, it is recognised that the getting of the coal after the chain machine is harder work than after the percussive machine, and accordingly a higher rate per ton is paid in several of the States.

A Jeffrey chain machine has been for some time at work in one of the Park Lane collieries, near Wigan, and the authors are indebted to the manager of those pits, Mr William Clark, for information concerning the machine, and the work performed by it.

The machine is driven by compressed air. The compressing plant, which is stationed at the surface, is compound in its action, and provides an abundance of power. It comprises a low-pressure air cylinder 16 inches in diameter, and a high-pressure cylinde 9 inches in diameter; the steam cylinder being 14 inches i diameter. The arrangement of the cylinders is shown in Fig. 35.

The intercooler is full of brass tubes, through which a constan stream of water passes. Both air cylinders are jacketed, and wate circulates through the spaces.

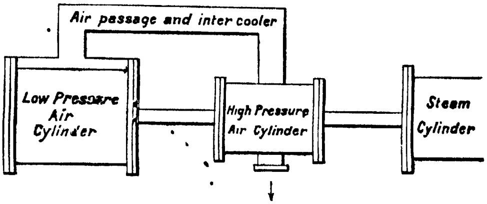

Air passage and inter cooler
Low Pressure Air Cylinder
High Pressure Air Cylinder
Steam Cylinder

FIG. 35.—SKETCH SHOWING ARRANGEMENT OF AIR-COMPRESSING CYLINDERS.

The air is taken down the shaft in 6-inch steel pipes, an delivers into a receiver at the shaft bottom; from thence a 3-inc steel pipe carries the air to point A (Fig. 36), where the pipes ar reduced to 2 inches diameter, for convenience of coupling an uncoupling the hose.

The pressure at the surface is 90 lbs. per square inch, an the same at the cutting machine when stationary, but when work- ing it falls to 76 lbs.

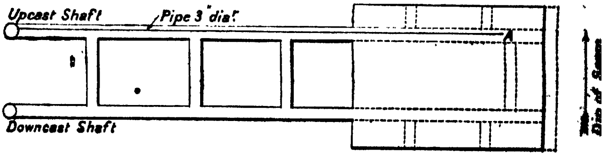


FIG. 36.—SKETCH OF UNDERGROUND WORKINGS, SHOWING POSITION OF JEFFREY MACHINE AT PARK LANE COLLIERY.

The place where the cutting machine is at present working i 50 yards wide, with two roads packed in the middle for intake an return air-way (see Fig. 36).

The section of the seam is as follows:—

Roof	Flaggy sandstone.
Coal	3 feet 9 inches to 4 feet.
Floor	Silicious stone—very hard.

The machine takes out a cut 3 feet 6 inches wide by 4 feet dee and 4½ inches high. The number of cuts which can be made in a given time depends, of course, on the state of the roof, and the quantity of timber which has to be knocked out and reset. In one case, it was found that the average number that could be made was six per hour, which means 7 yards in length undercut 4 feet deep or 84 square feet undercut per hour.

The time occupied in actually cutting the coal is only about three minutes, the remaining ten minutes being taken up in removing and resetting the machine. The engines and chain have worked remarkably well, and have given no trouble.

According to a statement of Mr R. S. Williamson,* the manager of the Cannock and Rugeley collieries, where these machines were in use for some time, an average length of holing 4 feet under, per shift of nine hours, in the Bass coal seam (5 feet thick) is 105 feet, yielding 65 tons of coal, and the saving in cost of labour as compared with hand holing 5½d. a ton, the cost per machine being 6.37d., as compared with hand holing 1s. per ton. Moreover, 12 to 15 per cent. more round coal is obtained.

It may be taken as clearly proved by practical experience that there are many seams where the adoption of coal-holing machines in place of hand holing will ensure (1) a larger output from the same area of workings with the same number of men; (2) more round coal; and (3) a lower working cost. This reduction in cost will be greater, according as the cost of labour is higher, and the holing harder.

Judging by published statements, 6d. per ton is an average saving, but it is doubtful whether cost of motive power driving the machines is fully considered in all the statements.

The working cost per ton is naturally the point which receives the first attention of the colliery manager, but it should not be overlooked that an increased production and an increased proportion of large coal may give a profit considerably outweighing even some increase in the working cost.

The North of England Mining Institute has recently issued a Report on Mechanical Coal-Cutting, in which are published the results obtained with machines undercutting longwall faces at about thirty collieries in various coalfields of Great Britain. The examples include all the best known machines and a great variety of natural conditions of working—thick seams and thin seams, level and inclined, good roofs and bad roofs, deep and shallow.

---

* *Trans. Fed. Inst. of Mining Engineers*, vol. vii. p. 307.

These examples show that 54 lineal yards of face undercut per shift may be taken as about an average performance per shift of a longwall machine, including all stoppages. In square yards undercut per hour it runs about 7 in seggar, 8½ in dirt bands and 9½ in coal. The cost of labour with the machine averages 4.73d. per ton, and the cost of getting the coal and of all other labour in the face 1s. 10.56d., making a total for all labour in the face of 2s. 3.29d.

The average saving in comparison with hand holing is 7d. a ton on labour in the face, but this 7d. has to cover the first cost of plant, the cost of power, and maintenance.

It seems that at the present time, when machines are being tried at many collieries in a tentative and experimental way, and the cost is therefore higher than it may be eventually, there is no overwhelming evidence of their saving in working cost under all the varying conditions of British collieries. But when we turn to the production per man and the percentage of large coal, the evidence is clear and decisive. Where 3 tons per man is got with hand holing, 4 tons may be obtained with the aid of machines, and 10 per cent. more of it as large coal. Another point to be observed is that the use of coal-cutting machines also tends to regular and systematic working—straight faces, careful timbering, a more scientific method altogether.

The rapid clearing away of the undercut coal is a matter of much importance; and in this connection the appliance known as Blackett's conveyor, which has been introduced recently, and is illustrated in Fig. 37, shows promise of being of valuable service in many instances of thin seams where there is not height for the tub to be taken along the face.

The contrivance is, practically, a chain-trough conveyor adapted to underground conditions. An endless chain of special design moves along a steel trough, the chain drum being driven through gearing off an electric motor or compressed air engine. The space occupied by the conveyor is about 10 inches high above the floor by 19 inches wide, and in length they are usually made to serve a face of 90 yards. The hewer fills his coal into the trough immediately behind him, and it is carried by the chain to the end of the face, where it falls off the conveyor into the tub standing on the going road to receive it. A large quantity of coal can thus be rapidly filled and sent away. No gate-roads are required, and much costly stonework is thus saved.

The chief difficulty is the moving forward of the conveyor as the face advances. The troughs allow of considerable bending, and are light and can be easily moved forward. But all the timber in the way needs to be removed and reset; and the support of the roof in the face presents a different problem from that usual, because there are no pack walls in the goaf behind.

In thin seams where the roof falls readily in the goaf, or bends down soon so as to make it solid, and where the face can be maintained without much timber, the conditions are favourable to this conveyor, and great economy may be secured by it.

Its practical application has been described by Mr F. O. Kirkup in a paper read before the N.A.C.M., North of England branch, on November 9, 1904. In a 2 foot 2 inch seam of hard coal a 100-yards face is being undercut by a Diamond disc machine to a depth of about 4 feet 3 inches, and the undercut coal got and cleared away by the conveyor every twenty-four hours. To move forward the conveyor and remove and reset the timber, a shift of six men go down every evening, and they can usually get it done in ten hours. The cost of this labour averages 7.70d. per ton. The face yields 80 to 90 tons of coal daily, and this is filled into the conveyor by eight men in about six and a half hours. Their labour costs 10.88d. per ton.

FIG. 37.—BLACKETT'S CONVEYOR.

In comparison with hand labour there is a saving with conveyor, after allowing fully for plant and power, of 1s. a ton, a it is stated that the increased quantity of round coal gives anot 1s. a ton on the selling value.

In other instances where this conveyor has been tried, owing great difficulties with the roof it has been found impracticable; b undoubtedly there are many seams where the natural conditio are such that it may be used with advantage.

To answer the same purpose of conveying the coal along t face in a thin seam so as to save making roads with its expensi stonework, low trams, which can be run along the face and empti into the ordinary tub standing on the going road, have been tri on several occasions. Recently, at Mickley colliery in Northu berland, considerable economy has been achieved by an adaptati of this system with an endless rope to pull the trams to and f along the face. A full description of this arrangement was giv in a paper by Mr J. W. Batey, read before the North of Engla Mining Institute in April 1905.

A machine of an entirely different type from any of those y mentioned is the well-known Stanley coal header, the inventi of Mr Reginald Stanley, of Nuneaton. The cutters are carried the ends of radial arms, and make an annular cutting leaving a co of coal in the centre which is removed as the machine advanc It is driven by compressed air. It has done much good work, a is the only machine of its kind in practical use. By its aid headin can be driven very much faster than by hand labour.

A "full cut" machine is also constructed, which does not ma an annular cut but removes the whole of the coal in front of It makes more small coal than the annular cut machine, b advances at a more rapid rate.

At Hamilton Palace colliery, N.B.,* where these headers we used in seams 7 feet and 6½ feet thick, over three months t average distance cut, 5 feet in diameter, was 259 feet per fortnig or 12 feet per shift. In some cases the rate of progress has be 1 yard per hour. At Nuneaton colliery, in driving a road 5 fe 6 inches diameter in the "slate" seam 10 feet 6 inches thick, t average rate of advance has been 10 feet per eight hours' shi with an annular cut machine.

The machine is especially useful in enabling a thick seam to b rapidly opened out after the shafts have reached it, particularly i deep sinkings where large shaft pillars must be left, and a good output of coal is desired as speedily as possible.

---

* I. S. Dixon. *Scotch Inst. Trans.* vol. xv. p. 4.

In spite of many failures and disappointments, coal-cutting machines have been gaining ground steadily, and are certain to play a larger and more useful part in the future of coal mining than they have done in the past.

CHAPTER IX.

DIFFERENT SYSTEMS OF WORKING—SOME COMMON CHARACTERISTICS.

Commencement of Operations at the Seam.—The shaft having been sunk to the seam of coal which it is intended to work it becomes the duty of the colliery manager to consider on wha principle, or by what mode, it will be most desirable to exploit an develop the available coal.

One of the first, if not the first thing that will claim hi attention after connecting the shafts by an underground passag will be the area of coal required to be left to support the shafts an buildings around them on the surface, and the number and directio of the narrow places to be driven for the purpose of "winning the coal.

In coming to a conclusion on this matter he must be guided b a variety of circumstances, prominent among which are the amoun and direction of the inclination of the seam, the direction of th cleavage of the coal, the position and extent of any known fault or "troubles," dykes, and nip-outs. The situation of the differen royalties, if the development of more than one is contemplated, i also a matter for initial consideration, so as to allow of there bein as few instrokes as possible.

The main roads (*a*) should be as central as possible for th whole area—*i.e.*, should win as much coal as possible; (*b*) shoul drain water from as large a proportion of the total area as possible (*c*) the gradient should be in favour of the full load coming "outbye' to the shaft; (*d*) any water met with should find its own way t the shaft; (*e*) the roads should pass through as few different properties as possible; (*f*) they should encounter as few faults a possible; (*g*) they should be driven as cheaply as possible.

A correct estimate and thorough consideration of these matter are most important, and the decision on the several points thu arising must be guided by the balance of advantage. In practice the predominating guides are that the main road (winning) should be water-level—that is, should rise about 1 in 200—and should be straight, and where there is a pronounced gradient of seam, this decides its direction. On the *inclination of the seam* will largely depend the mode of haulage to be adopted—whether self-acting inclines can be utilised to the saving of much initial expenditure, and an ultimate lessened tonnage cost, or whether mechanical haulage is necessary. The inclination of the seam will also affect the manner in which the drainage of the mine must be carried out—whether an engine for draining workings to the deep is necessary, or whether the mine can be drained by gravitation. The ventilation also will to some extent be governed by the inclination, more especially if the seam makes much gas. These points—as well, possibly, as others of material importance which are peculiar to the locality where the coal tract to be operated upon is situated—will arise for consideration and decision.

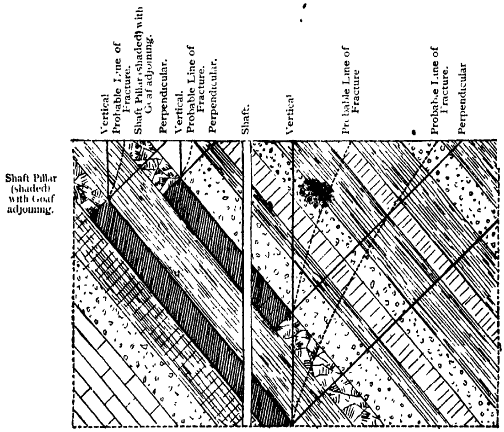

Shaft Pillar (shaded) with Goaf adjoining.
Vertical
Probable Line of Fracture.
Shaft Pillar (shaded) with Goaf adjoining.
Perpendicular.
Vertical.
Probable Line of Fracture.
Perpendicular.
Shaft.
Vertical
Probable Line of Fracture
Probable Line of Fracture.
Perpendicular

FIG. 38.—SECTION SHOWING COAL LEFT TO SUPPORT SHAFT IN AN INCLINED SEAM.

The gradient of the strata, when considerable, must also be taken into account in deciding the size of the shaft pillars, and their position relatively to the shaft, a larger area of coal being required on the rise than on the dip side. This is due to the fact that the fracture of strata by subsidence does not take place along vertical lines, but in a direction somewhere between the vertical an the perpendicular to the planes of bedding (except under abnorma circumstances, such as the occurrence of big faults or of runnin strata, such as sand or gravel). In the annexed illustration (Fi 38), the dotted lines show the probable lines of fracture, which ar curved and lie somewhere between the vertical and the perpendicula to the planes of bedding at the limits of the excavation. If th shaft be a shallow one, it will of course admit of smaller sha pillars being left than in a deeper one, but in no case shoul they be under 40 yards square. An important point also is th nature of the floor of the seam: where it is soft and heave readily, pillars must be left larger than otherwise would be necessary. The size of pillars cannot be calculated with scientific an mathematical accuracy, as many of the factors cannot be determined exactly, and experience is therefore the main guide toward the determination of the extent of coal to be so left.

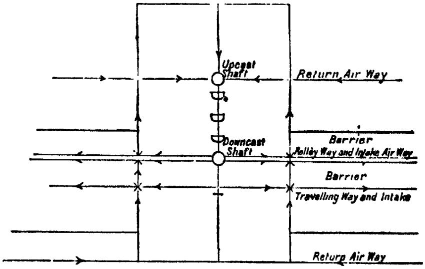


FIG. 39.—PLAN OF SHAFT PILLARS. Scale, 1 in. = 200 yds.

Under ordinary circumstances the following rule may be take as a fairly reliable guide to the sizes of shaft pillars required fo various depths, not exceeding 200 fathoms or thereabouts:— Taking a minimum size of 40 yards square at a depth o 60 fathoms from the surface, add 10 yards for every additiona 20 fathoms in depth. Some colliery managers, however, do no deem quite such a large margin to be necessary, but lay out thei shaft pillars on the principle that the size should be a quarte of the depth from the surface in yards square. But betwee these two rules it will be seen that there is not much to choose, th difference, whatever the depth, amounting only to 10 yards in th size of pillars. In Fig. 39 are represented the shaft pillars and winning places in a seam situate at a depth of 180 fathoms from the surface.

The area of coal to be left to support the shaft in level seams is perhaps best expressed as a radius round the shaft as centre. For instance, at the deep winning of the Barnsley bed in Yorkshire by the Cadeby Main shafts, 750 yards deep, a radius of 300* yards of coal round the shaft is left, and beyond that the whole of the coal is to be taken away by longwall work. Again, a recent sinking in South Wales is 433 yards in depth, and a radius of 100† yards round the shaft is being left.

Principal Methods of Working.—The two principal systems of working a seam to "get" the coal are those known briefly as (I.) Bord and Pillar, and (II.) Longwall. In the former, narrow places are first driven in the seam so as to form pillars, which are subsequently removed: in the latter, the whole of the seam is removed in a long "face," the roof behind being allowed to fall, or the excavation filled with *débris.* These are the two leading systems, and all other modes of working may be said to be modifications of one or the other.

The conditions favourable to bord and pillar working are as follows:—(1) If the roof contains water; (2) if much gas issues from the coal; (3) if there are many important buildings or reservoirs on the surface; (4) if the workings are beneath the sea; (5) if there is difficulty in obtaining sufficient material to pack the goaf; (6) if the top stone is of a loose nature and likely to fall in the working face; (7) if there are many "faults."

The conditions favourable to longwall may be stated thus:—(1) A seam free from faults; (2) a thin seam; (3) a seam of hard coal, difficult to hew; (4) a seam with a suitable roof, that bends, but does not easily break; (5) a seam with a "dirt" parting—*i.e.*, a band of soft stone; (6) a seam where either fireclay or ironstone is worked contemporaneously with the coal.

---

* A circle 600 yards in diameter = 262,744 square yards, ¼ of 750 yards = 188, which squared = 35,344 square yards.

† A circle 200 yards in diameter = 31,416 square yards, ¼ of 433 = 108, which squared = 11,664 square yards.

The pressure of the superincumbent strata seems to increase more rapidly at greater depths. Hence a rule applicable to shallow depths does not apply to greater depths.

Such are the conditions usually stated. It is seldom that a *single fact* determines the manner of working, but rather a series of general conditions point to the right conclusion. For instance, it is mentioned above that a thin seam, other conditions being favourable, can be most satisfactorily worked by longwall. Undoubtedly this is so, but at the same time a thick seam—even when free from band—can often be worked to best advantage by this mode, as will be shown later on (see pages 208 to 212). Again, much depends on the custom of the district, the *genius loci*, the adaptability of labour, &c.—considerations in dealing with which only knowledge and experience avail.

Under the longwall system there is less waste of coal, less timber is consumed in supporting the roof, and there is less narrow work (see Chapter XII.), and, if the seam is not naturally a very tender one, a higher percentage of "round" coal, amounting perhaps to as much as 14 per cent., is obtained than by bord and pillar. A larger proportion of the entire seam also—namely, from 10 to 25 per cent. more coal per acre—is obtainable by longwall than by bord and pillar. Longwall is the most suitable system for working seams at great depths, where the pressure of the superincumbent strata is serious, because this pressure is thrown on to the goaf, which is carefully packed with stone to support it, whereas in bord and pillar the pressure has to be carried by the coal pillars, which are thus crushed, with the result that the quality of the coal is deteriorated. Amongst other things in its favour, longwall costs less for timber, and there is less danger from falls of stone; it causes less damage to the surface, as the subsidence is more regular; it affords greater facilities for holing or kirving being done in "dirt," either below or above the seam; the number of off-hand men, relatively to the coal-hewers, is less than in bord and pillar. To put against this, however, is the increased cost of shift and stone work under the longwall method, entailed by the necessity of removing the top or bottom stone, as the case may be, in thin seams, to allow for tub and travelling height, and by the building of pillaring and the stowing of *débris*.

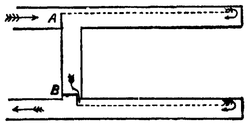


FIG. 40.—BRATTICING OF A PAIR OF WINNING PLACES.

Comparison of Labour Required.—The relative proportion between the principal classes of underground labour employed in the two methods is indicated by the following figures:—

	* Bord and Pillar.	† Longwall.
Number of hewers to one deputy	11	19
" " " shifter or stoneman	2.5	1.81
" " " putter	5	11.0

Ventilation of Drifts.—In seams generating gas, all roads in process of being driven should be divided by a partition, which may be formed of brick, wood, or canvas brattice, so as to form a separate inlet and outlet for the passage of air to and from the face.

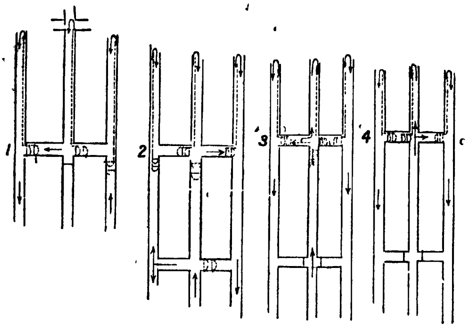


FIG. 41. FIG. 42. FIG. 43. FIG. 44.

PLANS SHOWING VENTILATION OF THREE WINNING PLACES.

The same end may be gained by wooden or metal tubes fixed along one side of the "place." The brattice should be carried to within about 6 feet of the face, and the intake air conducted up the narrow side,‡ as shown in accompanying Fig. 40, canvas doors or flaps being attached to the outer end of the bratticing, as at A and B.

---

* These figures are calculated on eight collieries working bord and pillar, over a total number of 945 hewers, the average tons hewed per man per shift being about 4.7. Instances of longwall have occurred where the number of stonemen and shifters has been greater than the number of coal-hewers.

† Calculated over four collieries working exclusively longwall, the total number of hewers being 1,200. The tons hewed per hewer per shift were 2¾, 70 per cent. of the output being "round" coal.

‡ It is a matter of dispute, whether, conducting the intake air up the narrow side, or up the wide side of the brattice, gives the better result in ventilating the face of a drift.

The face ventilation of three parallel drifts or winning headways is somewhat more complicated. The air may be conducted round the face according to four different modes—namely (1) when either the first or third place is the intake, Fig. 41; (2) when the middle place is the intake, Fig. 42; (3) when the middle place is the intake, Fig. 43 (another method); or (4) when the middle place is the intake, and the air is conducted up the *wide* side of the brattice in the intake or middle place, Fig. 44.

Peculiar cases sometimes occur. In driving a winning place in the Low Main seam at Killingworth colliery, the face was ventilated by means of a canvas brattice partition in the ordinary way. A blower of gas was tapped at the "leader" of a rise fault on the *intake* side of the brattice, and for some days gas came out at a steady pressure with considerable noise. To prevent this gas from being carried by the air current into the face upon the men at work, it was necessary to alter the bratticing. This was done in the way illustrated in Fig. 45. On the outbye side of the blower, the intake air was carried across to the other side of the place, and an air-crossing was formed of wooden deals to allow the return air to pass out over the top of the intake air. Owing to the rise fault, there was plenty of height. A, B, and C denote three canvas brattice doors hung from planks fixed across the place at a height of 6 feet above the floor. The double doors, A and B, prevented the intake air from escaping outbye when crossing over. Upon the planks was laid an air-tight partition of wooden deals. The arrows show the course of the air. Fig. 46, Plate XX., shows a canvas flap or brattice door, with a deputy on his rounds coming through it.

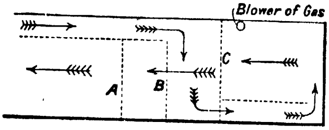


FIG. 45.—SPECIAL CASE OF FACE-BRATTICING IN THE PRESENCE OF A BLOWER OF GAS.

When a single place is being driven—as is often the case in approaching old workings known to contain a considerable quantity of water at a high pressure, the exact position of which it is necessary to locate, and possibly to drain off the water by means of such heading or drift—it becomes necessary to erect a more substantial and air-tight division than can be effected by canvas or wood, in which case a brick wall is usually built. Subjoined are the details of an actual case in point. The length of the brattice was 200 yards, and cross pillars were built every 9 feet, making sixty-seven pillars in all. The average height of the brattice was 7 feet 1½ inches.

WORK AND MATERIAL REQUIRED—

Area, exclusive of pillaring	455	square yards.
Area of pillars	20	"
Total area	475	"
Bricks to a square yard of 4½-inch walling ...	42	
Number of bricks in walling	19,110	
" in pillaring	560	
Total number of bricks in brattice ...	19,670	

COST OF MATERIAL—

	£	s.	d.
19,670 bricks at 21s.* per 1,000	£20	13	0
1 load of sand and lime will build 50 square yards of 4½-inch work. Therefore 10 loads at 3s. 10d. per load	1	13	4
	£22	6	4

COST OF LABOUR—

	£	s.	d.
475 square yards of brick walling at 6d. per square yard	£11	18	0
Leading bricks and lime, 16 shifts at 2s. 1d. per shift	1	13	4
	£13	11	4
Total cost (about 1s. 6d. per square yard) ...	£35	17	8

Wood brattice can be made very air-tight when built of planks inches thick with slivered joints—oak slivers 2 inches by ¾-inch—and the ends of the planks fastened into stringing planks 3 inches by 9 inches grooved about 1 inch deep to receive them. The weakest places are where the brattice joins the roof and floor, as these are seldom smooth or level, and lime plaster is useful for covering up the little spaces that may occur.

---

* The actual cost to the colliery of making these bricks was about 10s. per 1,000, the above being the market price.

PLATE XX.

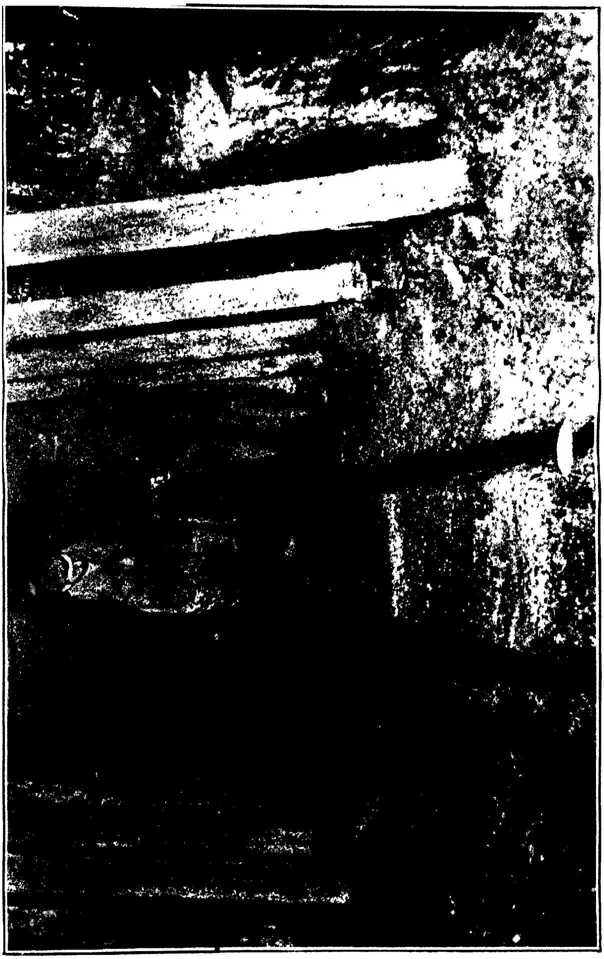


Fig. 46.—A Deputy on his rounds coming through a canvas brattice door.

[*To face page* 142.

[illegible] point of inferiority as compared with [illegible]. The latter also occupy less space, and can be [illegible] in or taken away. Their sectional area is often from [illegible] to

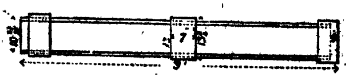


Fig. 47.—Air-Box. Scale, ¼ in. = 1 in.

[illegible] square inches. When made of wood, they are rectangular in section. Fig. 47 represents the usual description of box. The cost of making a 9 feet length of air-box of ¾-inch deals, 20 inches square inside, would be as follows:—

	s.	d.
7 yards of deal at 8d. per yard	4	8
15 square feet of deal at 10s. 6d. per 100 square feet	1	7
[illegible] lbs. of nails at 2s. per stone	0	8
Labour—¾-day at 3s. 8d. per diem	2	9
Cost of one length	9	8

Cost per yard = 9s. 8d. ÷ 3 = 3s. 2⅔d.

Air-tubes are somewhat more costly. At the time that the above calculation was made—six years since—the cost per yard of round steel air-tubes 15 inches diameter was 3s. 4d. The boxes or tubes may be laid either on the thill by the coal side, or (better still) carried along the side (some thickness of stone being left for their support) nearer the roof, as shown in Fig. 48, Plate XXI.

One great advantage which boxes and tubes have over wood or canvas bratticing is that a small ventilating fan, to be driven by hand, can be readily attached to them if more air is required. On the other hand, there is increased friction of air owing to their smaller area, so that possibly what is gained in diminished leakage is more than lost in increased friction. They are particularly suitable when proving "troubles" by following the "leader," when the floor of the excavation is irregular, and bratticing could not be conveniently adopted.

Air-Crossings and Stoppings.—Since the splitting of air in the ventilation of colliery workings was introduced, the subject of crossings has claimed attention from colliery managers, and even at the present time a diversity of opinion exists as to which type is best calculated to meet the requirements of any particul mine.

As a rule, after a colliery explosion of any magnitude the ai crossings and stoppings within the sphere of the explosion ar either completely blown out, or are so seriously damaged as t render them quite useless in the work of restoration of the ventilation. It is a moot point, and one which has given rise to muc discussion, whether air-crossings should be so strongly constructe as to effectually resist the explosive impact, or whether they shoul be so erected as to merely answer the purposes of the norma ventilation, and give way when subjected to the application of an abnormal force.

It is maintained by those who advocate the former view, that i the work of restoration it is most desirable that the rescue partie should be enabled to explore the workings and relieve the sufferer as early as possible—before, in fact, after-damp may have had tim to take fatal effect; for it is generally acknowledged that fatalitie due to colliery explosions are more largely caused by this deadl mixture than by explosive violence. If, then, the air-crossings an stoppings are only indifferently strong, they are sure to be s damaged as to be of little or no use in the work of re-establishin the ventilation.

Those, however, who support the second view, contend that th object to be secured is the limitation of the explosive force, and a in most modern colliery disasters the explosive current has traverse the haulage roads (which are in nearly every instance the intake also), they argue that by constructing intensely strong air-crossing and stoppings, the mechanical violence of the explosion is prohibited from finding its quickest outlet by passing into the return and thence to the upcast shaft—short circuiting in fact—in place o which it is confined to the intakes, and must traverse the greate part, if not all, of the workings, gathering intensity as it sweeps along the haulage roads from the coal dust which is often so plentiful in these galleries.

But cases could be quoted to show that even where the crossings and stoppings have been blown out, the explosion has continued its course along the intake. The course and extent of the explosion would seem to be mainly dependent on the presence of explosive material.

That air-crossings and stoppings have to be very strong indeed to successfully resist the force generated by a colliery explosion has been instanced in more than one case. At Elemore colliery, in

PLATE XXI.

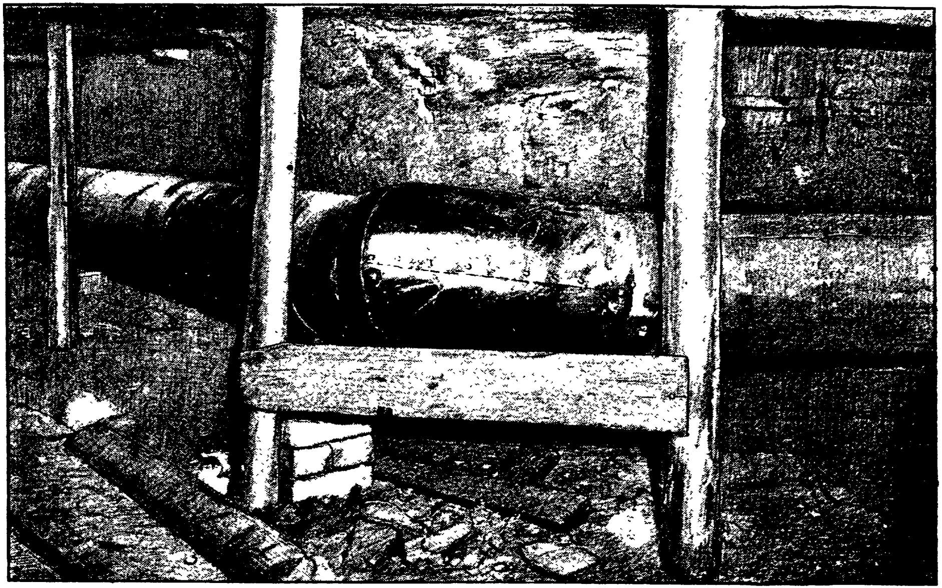


Fig. 48.—Air Tubes carried round a corner, and ventilating a single heading.

the county of Durham, which "fired" in December 1886, the bric stoppings, and in several instances the arched brick air-crossing were completely blown out. Mr Thomas Lishman, the able genera manager of the Hetton collieries (including Elemore), is of th opinion that "all main air-crossings in close proximity to the shaft

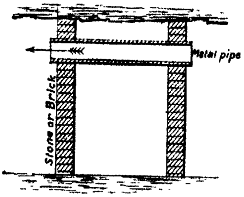


FIG. 49.—PIPE AIR-CROSSING.

where there are usually a considerable number in all mines of an magnitude, should be inserted in the strongest possible way, so tha in the event of an explosion, the ventilation to the different district which usually diverge from the main lines beyond such crossing may be more readily restored." This expression of opinion deserves the careful consideration of the managers of extensive an

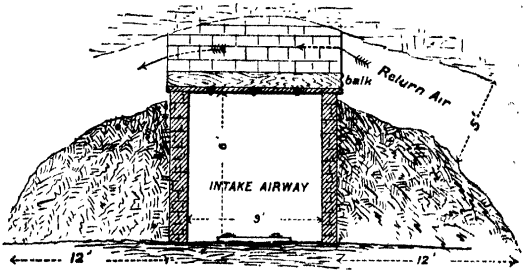


FIG. 50.—WOOD-TOPPED AIR-CROSSING IN SECTION.

fiery mines; but under ordinary conditions the wood-topped air crossing and the common brick stopping, well plastered with lime meet the requirements of the case.

There are several kinds of air-crossings in use, each of whic has its peculiar fitness and special merits. The chief types may b stated as follows:—(1) Metal pipe crossing; (2) Wood-topped crossing; (3) Flat-topped hinged-door crossing; (4) Single-brick arched crossing; (5) Double-brick inverted arch crossing; (6) Air-crossing cut out of the solid strata.

(1.) The pipe crossing, which is shown in Fig. 49, is only to be regarded as a temporary arrangement, and merely for conveying small volumes of air.

(2.) The wood-topped crossing (Figs. 50 and 51), which is perhaps the type most frequently adopted, consists of strong redwood deals, 3 inches by 11 inches, supported on side retaining walls of 9-inch brick, or of stone masonry, at the back of which the *débris* from the space excavated to form the air-crossing is heaped. The deals forming the top are clinched tight together by iron clamps, as shown in Fig. 51. Sometimes "slithering laths" are dovetailed between the deals, which ensures still greater air-tightness.

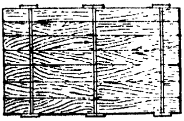


FIG. 51.—PLAN OF TOP OF WOOD-TOPPED AIR-CROSSING.

The cost of inserting such a "crossing" will be approximately in accordance with the following actual instance:—

COST OF AIR-CROSSING.

WASTEMEN—	Shifts.	£ s. d.	Labour. £ s. d.	Materials. £ s. d.
Preparing for blasting ...	6	0 3 3	0 19 6	...
Blasting	15	0 3 3	2 8 3	...
Ridding and pillaring ...	40	0 3 3	6 10 0	...
Putting and stowing ...	30	0 3 0	4 10 0	...
Preparing for side-walls, putting in back-walls, and stowing	17	0 3 3	2 15 3	...
Putting on timber ...	6	0 3 3	0 19 6	...
Assisting masons with bricks and lime	6	0 3 3	0 19 6	...
			19 2 0	

MASONS—	Shifts.	£ s. d.	Labour. £ s. d.		
Building walls	10	0 3 8	1 16 8		
Labourers ...	6	0 3 0	0 18 0		
				2 14 8	...
Carry forward			...	21 16 8	...

		Labour. £ s. d.	Materials. £ s. d.
Brought forward		21 16 8	...
MATERIALS—			
2 balks Dantzic pine, 15 feet × 9 inches × 9 inches each, 17 cubic feet	0 0 10	...	0 14 2
11 pieces 11 inches × 3 inches red deal, each 15 feet long, 165 lineal feet	0 0 $2\frac{15}{16}$	...	2 0 5
20 pieces $7\frac{1}{2}$ inches × 3 inches × $\frac{1}{2}$ inch laths, 150 lineal feet	0 0 $0\frac{1}{4}$	...	0 3 2
40 spar nails (10 lbs.) and 3 lbs. small nails, 13 lbs.	0 0 $1\frac{1}{2}$	...	0 1 8
2 pair of iron clamps 1 cwt. at 1s. ...	...	...	0 1 0
Labour screwing	...	0 3 0	...
4,650 bricks at 13s. per 1,000 ...	...	...	3 0 6
Lime at 5s. per 1,000	...	...	1 3 3
Powder, 43 lbs. of compressed cartridges at 34s. per 100 lbs. ...	...	...	0 14 8
			7 18 10
			21 19 8
Total cost of labour and material			29 18 6

(3.) The only difference between the hinged-door crossing and the one above described is that the wooden top is made in two halves, being two doors working on hinges and opening upwards, and so arranged that in no case will they *remain* open, but upon the removal of the opening force acting from beneath, they fall to again and close tight. The object which it is sought to arrive at by this device has already been alluded to, namely, the

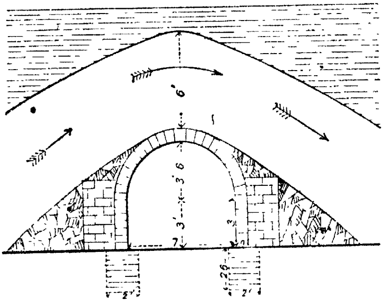


FIG. 52.—BRICK-ARCH AIR-CROSSING, IN SECTION.

creation of an escape exit for the violence induced by a colliery explosion.

(4.) The single brick arched air-crossing is a type in common use, and is fairly strong and air-tight, and where the top or side stone is of a short or broken nature, it is a desirable form of crossing to adopt. It is of course somewhat more costly to erect than the flat-topped wooden air-crossing, but where the stone is of the indifferent character here indicated it would prove the more durable, and hence in the long run the cheaper of the two.

The accompanying sketch, Figs. 52 and 53, represent an actual instance. Special foundations 2 feet 6 inches deep, consisting of well-packed rubble stone covered with a coating of cement at the floor level, were laid, on which to build the brick-work, as there was no hard stone above this depth. Strengthening walls, o, o, o, were built at intervals of about 2 yards, and the spaces between well packed with stone. The top of the arch was coated with cement, as water dripped from the stone above.

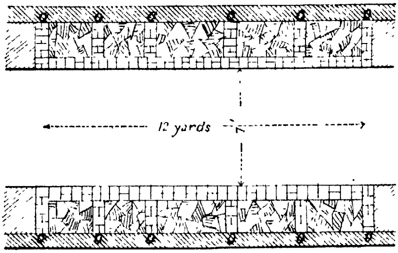


FIG. 53.—BRICK-ARCH AIR-CROSSING, IN PLAN.

(5.) The inverted brick arched crossing is perhaps the strongest form of crossing that is constructed by artificial means. It is the ordinary brick arched crossing with an inverted arch placed in the return airway over the crown of the intake arch, so that the crowns of the two arches meet, the interstices so formed being filled in with solid masonry. Besides being capable of resisting very considerable explosive force, it is a serviceable form of crossing in cases where uneasy strata have to be dealt with. Instances have occurred, however, where even this form of air-crossing has not been strong enough to resist the upward pressure of the floor, and has required renewal after a few months.

(6.) The solid air-crossing, which is the strongest and most costly of the various types enumerated, is made by driving a stone-drift for a return airway over the top of the intake, and leaving several feet of solid strata between.

Figs. 54 and 55 represent a plan and section of a form of air-crossing in use at Celynen colliery, in South Wales, the peculiarity

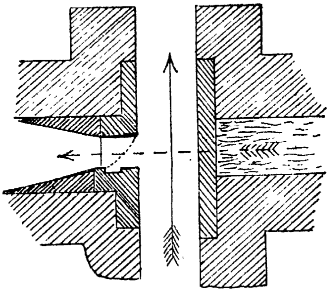


FIG. 54.—SPECIAL FORM OF AIR-CROSSING, IN PLAN.

being a door in the side, which enables the mine official to pass direct from the main intake into the main return airway at the crossing.

In all cases where stoppings are located on the outbye side of the "regulator"—"main stoppings," as they are termed—they should be built of solid masonry, either of brick or of stone, and in addition be well plastered over with lime to prevent the air scaling.* They may be strengthened by stowing the bord or stenton *behind* with stone and rubbish; but the side facing the intake should always be visible for inspection and kept quite clear of rubbish.

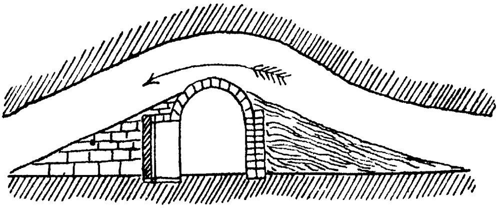


FIG. 55.—SPECIAL FORM OF AIR-CROSSING, IN SECTION.

---

* The leakages which occur in the volume of an air current during its passage from the downcast shaft to the working face are often surprisingly large, amounting sometimes to 84 per cent. of the entire volume (see "Notes on a Ventilating Current," by Henry Palmer, *Brit. Soc. Min. Stud.*, vol. xi., p. 46). The state of the stoppings greatly affects this.

CHAPTER X.

WORKING BY BORD AND PILLAR.

"BORD and pillar," "Bord and wall," "Stoop and room"—or b whatever other local designation the system may be known—is th oldest system of working coal on record, as will have been inferre from the opening chapter of this volume. The object originall aimed at was the extraction of as much coal as possible in a singl working, without allowing the roof to fall. The advance from thi point to the leaving of larger pillars, with a view to subsequent extraction—the improvements in working and ventilation generally—and, in fact, the evolution of the whole system up to its presen pitch of efficiency—have been fully dealt with in the openin chapter, and we now pass on to a consideration of the practica details of the system, as at present carried out.

The bord and pillar system took its rise in the Northern coal field (Northumberland and Durham), and is still the prevailin method of working there. The account of it now to be given i therefore, not inappropriately derived (for the main part) fro experience in that district.

Winning Places and Main Roads.—We have already referre to the formation of the shaft pillars, and this work being complete the colliery manager's next duty is to set away "winning places or exploring roads which will in all probability be the main road of the pit, both as regards haulage and ventilation, so long as th seam shall continue to be worked. The necessity, therefore, o driving these roads in such directions, and in such manner, as wil best secure the advantageous working of the seam (see page 135 need hardly be emphasised. If possible (though local circumstances such as position of royalties, &c., may prevent it) these roads should be projected from both sides of the drawing pits, so that any stoppage on one of the roads will not entail an entire cessation of th drawing of coals.

In the working of these "places"—which in most cases should be three in number, parallel to each other—many irregularities may be encountered—such as, in miners' phraseology, rise or dip troubles or faults, swellies, nip-outs or wash-outs,* which of course considerably impede the prosecution of the work of laying-out the mine. Fig. 56, Plate XXII., is a reproduction of a photograph which was taken in the face of a winning headways driven in the Brockwell seam at a Durham colliery. The normal thickness of the seam is 3 feet, but this photograph shows an abnormal thickening of it, the whole height here being 11 feet, about 2 feet of which is stone. Water was raining down from the roof, and to the right of the view may be seen a screen or "picture" put up to keep the water from falling on to the hewer. Fig. 9, Plate VIII. (page 84), was taken in the face of the same winning a few yards farther on, when the coal seam had disappeared altogether, and progress had to be made through stone. Not unfrequently a seam thickens considerably in the neighbourhood of a "nip-out," as was here the case.

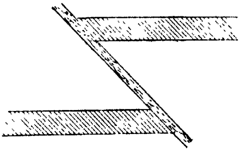


FIG. 57.—SECTION SHOWING REVERSED FAULT.

These two plates illustrate some of the vagaries and irregularities which are often encountered in driving winning places. The winnings of the coal, however, will not be deviated from their predetermined course, unless, indeed, such a disastrous circumstance as a complete "wash-out" of such considerable extent as not to warrant the cost of stone-drifting through it, or a very large fault, or general thinning out of the seam, or other equally fatal deterioration, be encountered. Irregularities of gradient are subsequently removed, as the "face" working advances, by following up with "top" or "bottom" stone "canches"; and thus such gradients are formed as are best suited to the mode of haulage it is deemed advisable to introduce.

Allusion has been made to the meeting with faults when driving these main levels. It is important, when such are encountered, that their character should be known—whether upthrows or downthrows, or (as is rarely the case) "reversed" faults (see Fig. 57). As a rule the direction of the "leader," or wall of soft stone or clay filling in the space between the opposing face of the dislocation and the coal seam (see Fig. 58), determines this point; for, if a fault *lies to* at the "thill" or floor (that is, forms an obtuse angle with the floor), and *back at* the roof (making an acute angle with the roof), it is concluded to be an "upthrow"; and so *vice versâ*. Faults are seldom vertical. If a fault is encountered having a perpendicular face, the usual mode of procedure is to drive a short drift across the leader, when, with a knowledge of the strata lying above and below the seam, the position of the coal may often be rightly judged; or if not, then, when *quite* clear of the leader, a bore-hole may be put up or down to locate the position of the seam.

---

* For meaning of these terms, see GLOSSARY.

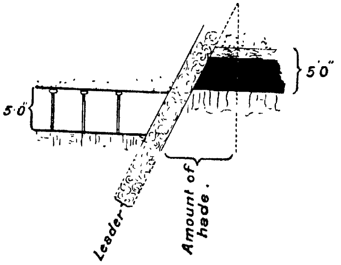


FIG. 58.—SECTION EXPLANATORY OF A FAULT.

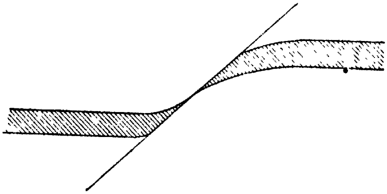


FIG. 59.—A FORM OF FAULT.

It frequently happens that the ends of the faulted seam are curved, as shown in Fig. 59, which fact often affords useful information as to the presence and direction of a fault. Pieces of

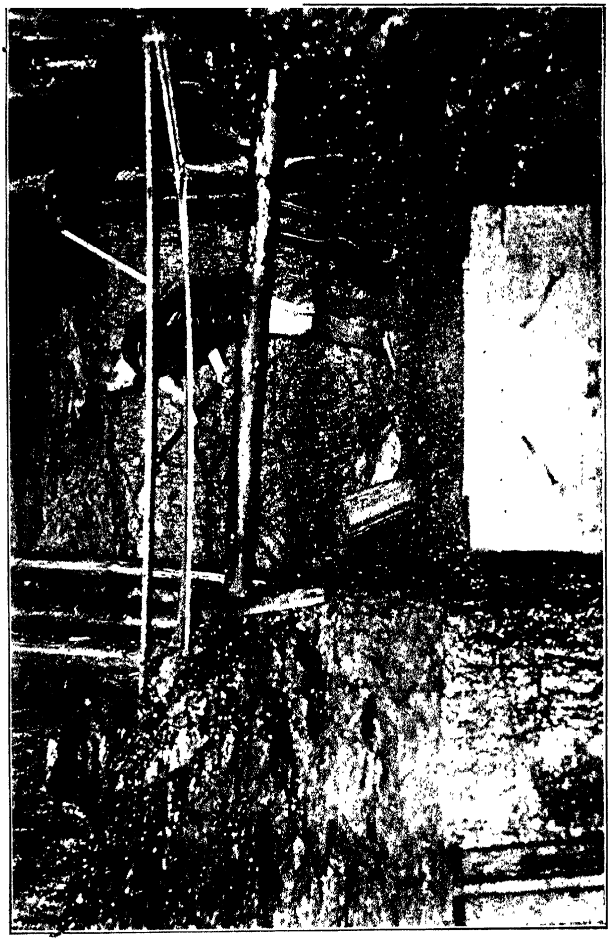


Fig. 56.—Face of a Winning headways, showing an abnormal thickening of a thin seam.

coal are sometimes found drawn up or down into the intermediate strata of the leader, showing the track or course of the dislocation. "Faults" are the principal cause of stone-drifting in coal-mining, and reference may here be made to questions which commonly arise as to the probable length of such drifts.

(1.) Suppose the perpendicular depth between two parallel seams, which are dipping at the rate of 1 in 18, to be 20 yards, and it is desired to pass from the upper to the lower by means of a level drift (Fig. 60); it is required to know the length of the drift to be driven from the one to the other. For every *horizontal* length of 18 yards, the lower seam rises 1 yard: hence the drift will be 20 yards × 18 yards = 360 yards in length before it touches the seam.

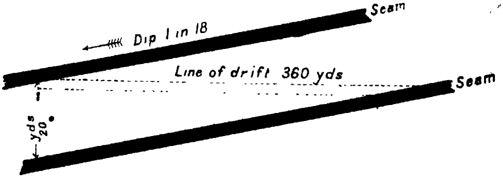


FIG. 60.—DRIFTING BETWEEN INCLINED SEAMS.

(2.) Suppose that a 20-feet dip fault be encountered when driving the main levels, say, in the coal (see Fig. 61), and the inclination of the seam be the same at both sides of the fault—viz., 1 in 18—and it be desired to pass by means of a horizontal drift from the one side to the other. The length of the drift will be 20 feet × 18 feet = 360 feet. To calculate the distance from the point *c* at which it will be necessary to set away a drift *in the seam*, we may proceed thus:—

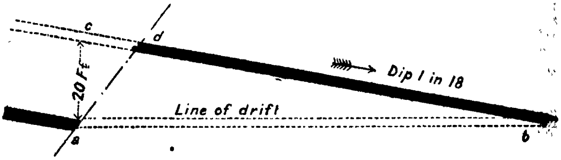


FIG. 61.—DRIFTING THROUGH A FAULT.

$$ab = 18 \times 20 = 360 \text{ feet.}$$

$$cb^2 = ac^2 + ab^2$$

$$= 20^2 + 360^2 \text{ and } cb = 360.5 \text{ feet.}$$

(3.) If the seam in the last instance be taken as level at both sides of the fault (Fig. 62), the length and gradient of the drift would be determined thus:—Supposing the distance from the "staple" to the point at which the drift is to be set away is 300 yards, and the staple 20 yards deep: then

$$ab = \sqrt{20^2 + 300^2} = 300.7 \text{ yards} = \text{length of drift.}$$

$$\frac{300}{20} = 1 \text{ in } 15 \text{ is the gradient of the drift.}$$

It is obvious that in the case of a large upthrow or downthrow fault it is necessary to drift through the stone to reach the seam. This work is carried out by the "stonemen," who enter the place when evacuated by the hewers, by whom work of this kind is not usually undertaken. As a rule the stone work is done by contract (see Chapter VI.).

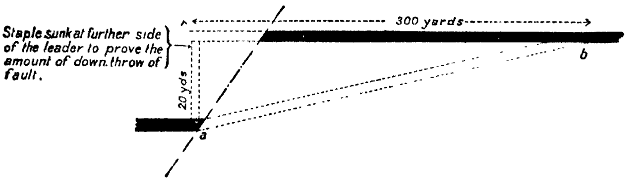

Staple sunk at further side of the leader to prove the amount of down.throw of fault.
300 yards
20 yds
a
b

FIG. 62.—DRIFTING THROUGH A FAULT.

The size of the drift will be the same as that of the winning—namely, such as will meet the requirements of haulage and ventilation. The "back" or return-air places need not necessarily be drifted, as a staple will suffice, either inclined or perpendicular (see pages 85 and 93). Of course if four places are being driven, and the system of haulage is such as to make a separate travelling road a desideratum, a second drift will have to be driven for the passage of men and horses. An inclination of 1 in 4 (9 inches per yard) will be found to be about the steepest gradient at which such a road should be driven.

The *gradient* of the main road is a very important point, as may be easily imagined. Presumably that gradient will be the best where the amount of work performed by the horse or machine in drawing the *full* load out is equal to that expended in taking the *empty* load in. This will be found on calculation to be a rise *from* the shaft of about 1 in 120, if the co-efficient of friction of coal-tubs on rails be taken at $\frac{1}{60}$.*

The accuracy of the gradient is assured by the men and officials constantly checking it by means of a levelling lath or tee-bob,

---

* The formula for calculating this is as follows :—

$$G = \frac{L - E}{L + E} \times F$$

Where G = gradient (which is a whole number: *e.g.*, $G = 10$ for a gradient of 1 in 10).

F = fraction representing friction (co-efficient of friction).

L = total load = tubs + coals.

E = weight of empty tubs.

Thus, if we have a weight of, say, 15 cwt. on an incline of 1 in 120 fall towards the shaft, the forces acting on this load are :—

(1.) *Gravity* = a force of $\frac{1}{120}$th of 15 cwt., or $\frac{1}{8}$ cwt., tending to *pull* the load down towards the shaft.

(2.) *Friction* = a force of $\frac{1}{60}$th of 15 cwt., or $\frac{1}{4}$ cwt., acting as a *retarding* agent.

Therefore there is a *minus* force—regarding the shaft direction as *positive*—of $\frac{1}{8} - \frac{1}{4}$ or $\frac{1}{8}$ cwt., *i.e.*, a force of $\frac{1}{8}$ cwt. against movement down the incline.

Again—considering the problem as of an empty and full "set" on an inclined plane, which is of such an inclination that the two "sets" are just balanced.

Then the full load (divided by the gradient), less the fraction for friction, *will equal* the empty load (divided by the gradient) plus the fraction for friction.

Hence we arrive at the following equation, and finally the formula, for discovering the best gradient for a haulage load :—

$$\frac{L}{G} \text{ (acting downhill)} - FL \text{ (acting against movement downhill)}$$

$$= \frac{E}{G} + FE$$

$$\therefore \text{ transposing } \frac{L}{G} - \frac{E}{G} = FL + FE$$

$$\text{and } \frac{1}{G}(L - E) = F(L + E).$$

$$\text{Dividing by } L - E \text{ we have } \frac{1}{G} = \frac{F(L+E)}{L-E}$$

$$\text{and inverting } G = \frac{L - E}{F(L+E)}$$

constructed to suit the gradient determined upon. Fig. 63 represents a levelling lath, and Fig. 64 a tee-bob, made for a rise of 1 in 12.

The *direction* of the main roads is a matter of equal moment to that of the gradient, and having been carefully determined beforehand, should in course of fulfilment be constantly checked by the surveyor by means of the compass or theodolite. The usual method pursued is to fix in line with each other in the axis of the "drift"—that is, in the course at which the drift has to be driven—two or three vertical strings or plumb-lines suspended from the roof, a few yards distant the one from the other, and at a sufficient distance back from the face to ensure their not being deranged by the blasting operations. Standing at the farther outbye plumb-line, and sighting it in line with the others, this line may be prolonged into the working face, and a chalk mark made on the roof to guide the men who are driving the road. By this means the direction in which the "place" is going may be checked at any time. Whenever it is deemed desirable to shift the plumbs farther inbye, their relative positions should be redetermined by means of the compass or theodolite. These plumbs—or rather the points from which the strings are hung—should be fixed near one side of the road, rather than in its centre. If the road is driven crooked, a sight along the

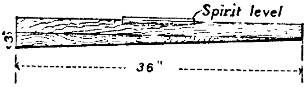


Fig. 63.—Levelling Lath.

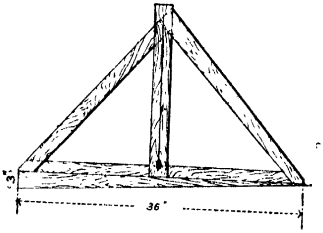


Fig. 64.—Tee-Bob.

plumb-lines, when hanging near one side, will strike one side of the road and soon show the deviation.

Curved Roads.—This mode of procedure with respect to driving straight roads is simple and easily understood, but when it is necessary or desirable to drive a road on a curve—as for instance at the point of junction of a branch road with a main road (especially where the mode of haulage is main and tail rope, and the radius of curves is important), it is somewhat more complicated. Supposing it is desired to drive a curve of say 70 yards radius between the points A and B for an engine way. First determine the *magnetic* bearings of the two roads, then plot these as shown in the sketch (Fig. 65). Join A B by a straight line and bisect the same; and with radius (70 yards) describe the arc as shown. Draw the lines A*a*, *ab*, *bc*, *cd*, *de*, making them as equal as possible. Having done this, determine the course of these lines, as it is by these courses that the curve will have to be driven. As there will necessarily be a corner or "knob end" where a course terminates and another one commences, these are afterwards trimmed off by the hewer. Care must be taken to keep the marks in the centre of the place, otherwise the curve when complete will not be a true segment of a circle.

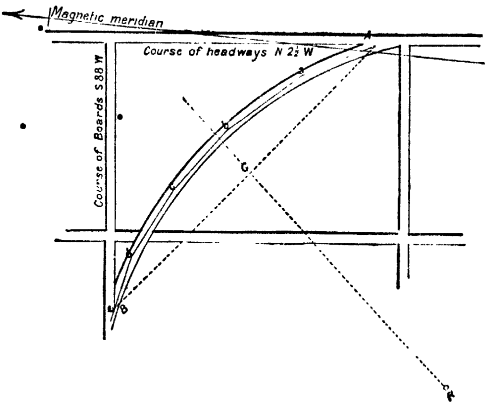


Fig. 65.—Mode of Laying-out Underground Curved Road.

A curve may also be driven by means of plumb-lines. Suppose that it be desired to connect the two roads A B, C D (Fig. 66), by a road on a curve of 1 chain radius. To find the required offset in inches, divide the square of the distance between the plumb lines in inches by the radius of the curve in inches. Assuming that 11 feet is the distance between the plumb-lines, then

$$\frac{(11 \text{ feet} \times 12)^2}{792} = 22 \text{ inches.}$$

As each length of 11 feet is driven, the back plumb-line must be moved 22 inches at right angles to the previous line, and the line between the two plumbs then gives the direction for the succeeding 11 feet of road.

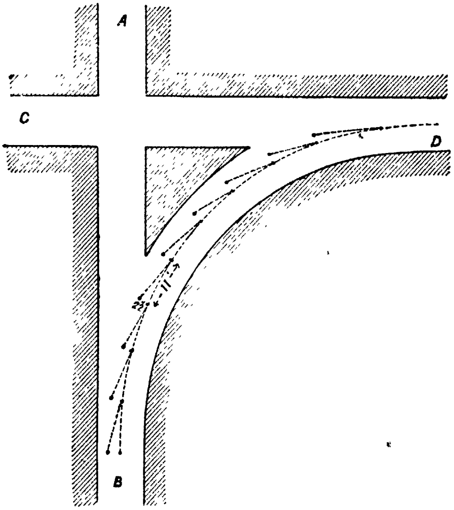


FIG. 66.—MODE OF LAYING-OUT UNDERGROUND CURVED ROAD.

The winning places having been driven a sufficient distance to allow of the fuller working of the seam, it becomes necessary to consider the manner in which the districts must be laid out, the size of the pillars, and the accompanying details. At the present day, when competition is so keen, and the most careful economy has to be practised in even the smallest items, the question of "produce" or yield of round coal is one of vital importance. It is, therefore, necessary, before laying out districts of pillar workings, to carefully consider all the varying peculiarities of the seam, and to leave such pillars as, being adapted for removal with safety to workmen, will also yield a good percentage of round coal, and can be economically worked. The authors do not pretend, nor indeed do they think it possible, to lay down any hard and fast lines as to how this system of working should be carried out in all cases, as the circumstances at various collieries are so many and diverse as to necessitate the adoption of different methods both in the laying out of pillar workings and in their removal. Before they proceed to enumerate and describe in detail some of the methods that have come under their actual observation, a brief general description of the system of working may be given.

Panels.—In Fig. 67, Plate XXIII., the main winnings are represented by *a*, *b*, *c*, *d*, *e*, *f*, and the districts, or "panels," by the letters A, B, C, D, &c. As already stated (page 9), the honour is due to Mr Buddle of having been the first to lay out workings on the panel system, and to demonstrate its practical advantages. The panel system * is briefly this:—The pit is divided into districts of varying area—30 acres or more—separated from each other by barriers of solid coal, generally from 30 to 60 yards wide, which, when the district or districts are being brought back in the broken, are removed in the manner to be described further on. The advantages derived from the introduction of this improvement in the bord and pillar system of working, such as the separate ventilation of each district, localisation of creep, and in some cases the force of explosions,* &c., have been already noticed (see Chapter I.).

---

* In connection with panel working, an interesting point was raised in the case *Wales* v. *Thomas* (High Court of Justice, Queen's Bench Division, 6th November 1885), respecting the meaning of the expression "out of the mine *or part of the mine*" in the Mines Regulation Act of 1872, and involving the question under what circumstances shots may be fired. "Timid people," said Mr Justice Day in his summing up, "are invariably getting into difficulties which other people avoid, and that is constantly the result of using words out of abundance of caution: you raise doubts and difficulties which would otherwise never have arisen at all. Having provided that 'part of a mine' having a separate system of ventilation shall be a 'mine' for the purposes of the Act, it was, no doubt, quite unnecessary to say that persons shall be "out of the mine or out of the part of the mine' where gunpowder is used." *Part* is equivalent to *panel*, which under the Act of 1872 could be regarded as a mine; where not divided into panels, then the men would have to be out of the pit proper when shots were fired, *part* in this case being used as in common parlance, whereas a panel has a separate intake and return airway of its own, and is to all intents and purposes a separate mine.

Size and Shape of Pillars.—As in the case of shaft pillars, so also with ordinary pillars, the question of size is most important, but this has to be considered in connection with the manner of working them, no less than with the depth of the seam from the surface. When, for instance, the "whole" is followed up closely by the "broken," a smaller size will suffice than when the pillars have to stand some time before removal.

The dead load or statical pressure is sometimes asserted to increase directly as the depth of the seam from the surface, and to be the product of the depth into the average density of the overlying beds. A cubic foot of sandstone weighs roughly 150 lbs., of shale 160 lbs., of coal 82 lbs. As the strata of the Northern coal-field consist of frequent alternations of these, usually in the proportion of 20 sandstone and 12 shale to 1 coal, the average weight may be taken at 144 lbs. per cubic foot, or at the rate of 1 lb. per square inch for each foot in depth from the surface. The crushing strain of coal has been roughly estimated to be from 2,000 to 4,000 lbs. per square inch. Therefore at a depth of 2,000 to 4,000 feet the statical pressure on a coal seam is equal to its cohesive strength.

It is very doubtful, however, whether the actual top pressure on a seam is directly proportional to the depth. Certainly in practice it is often easier—that is, it requires less timbering, &c.—to support the roof of a mine in a seam 150 fathoms deep than in one 30 or 40 fathoms deep. Much depends on the nature of the strata for 2 or 3 fathoms immediately above the seam. From the numerous instances hereinafter mentioned (see Chapter XI.), it may be gathered that in actual practice, the size of pillars is certainly not proportional to their depth. In deeper mines, 700 and 800 yards, much difficulty has been experienced from the heavy pressure, which in some instances has crushed brick arching, 3 to 4 feet thick.† The pressure seems to be *relatively* greater at greater depths than in shallower mines. Thus Mr Forster Brown states "that in South Wales, where there was a great pressure at 2,200 feet, at half that depth there was not a corresponding pressure." At great depths the difficulties of pillar working will much increase.

---

* In some of the heavy colliery explosions of modern times, however, in which coal dust has played such an important part, the explosive force has been generated or propelled along the main roads of the mine irrespective of districts. The panel system, therefore, does not in such cases appear to have much localising influence.

† See *Fed. Inst. Trans. of Mining Engineers*, vol. viii., p. 410, paper on the South Staffordshire Coal-Field, by F. G. Meachem.

It has been stated as a general rule that at the depth of 50 to 100 fathoms from the surface, pillars should be 30 by 40 yards; from 100 to 150 fathoms, 40 by 50 yards; and from 150 to 200 fathoms, 40 by 60 yards, or 50 by 50, and so on.

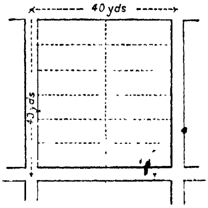


FIG. 68.—PLAN OF A SQUARE PILLAR.

The shape of the pillar is also important. A square pillar is probably the best support for the top pressure, but as a matter of fact pillars are oftener made oblong, as being easier to work off in the second working, the "juds" (as the successive slices whereby the pillar is removed are termed) not having to reach so far as in the instance of a square pillar, or where it is necessary to "jud" from one side of the pillar only. See annexed illustrations, Figs. 68 and 69.

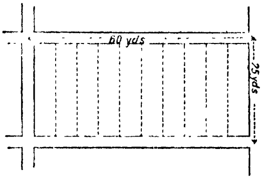


FIG. 69.—PLAN OF AN OBLONG PILLAR.

The size of a pillar should be such as to prevent any general movement of strata, either in the whole working, or at the face in the broken working. When pillars are left too small, the well-known results termed "creep" and "thrust" ensue, as already described (page 5).

The relative proportions of coal wrought by the first and second workings—that is, by "whole" and "broken"—is of course determinable by the proportionate areas of excavation (bords and walls) and pillars. To give an instance (see Fig. 70). The bords are driven 6 yards wide, and are 50 yards long, centre to centre. The walls are 3 yards wide, and 30 yards long, centre to centre. The pillars are said to be 30 × 50, centre to centre, but the actual area of coal left is equal in area to 24 × 47 = 1128 square yards. Therefore there is excavated in the first working an area equivalent to 372 square yards, or 24.8 per cent. of the coal is worked in the "whole." In this calculation no allowance has been made for turning the bord away narrow, as is often done, the first and last two yards of the bord being 3 yards wide instead of 6 yards. This leaves more support for the roof where the two roads cross. If great accuracy is desired, this would have to be taken into account in the calculation.

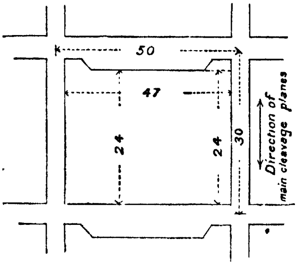


FIG. 70.—SKETCH ILLUSTRATING PROPORTION OF COAL LEFT IN PILLAR (Dimensions stated in yards).

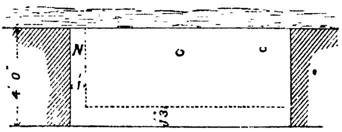


FIG. 71.—SKETCH SHOWING POSITION OF KIRVING, NICKING, AND SHOT-HOLES.

The manner of working the coal at the face, as pursued by the coal-hewers, claims some attention. Where the seam is a soft one, and round coal is not particularly wanted—as, for instance, where it is made into coke, or used for making gas—the coal will be hewn down in such manner as suggests itself to the hewer as best fitted to secure merely the largest possible quantity. If, however, the seam is a hard one, or large (that is "round") coals are wanted, as is the case with steam and household coal seams, certain modes have to be adopted by the hewer in order to work his place to the best advantage, and at the same time produce the highest possible percentage of round coals. He will, therefore, undercut, or, as it is locally called, "kirve" or "hole" the seam across the full width of the place (bord, or wall, as the case may be). This excavation should not exceed about 15 inches in height at the face, tailing out to nothing, and running generally about 3 feet into the seam. This process is known as "kirving a jud," and is preparatory to bringing down the coal by shot-firing or by wedging. In order to loosen the overhanging coal at one side, and also to save shattering effects on the coal where the shot is fired, the "place" is "nicked" up one side (N, Fig. 71), the shot being placed at the other side. The kirving and shot-hole are shown in section in Fig. 72. Fig. 73 represents a "cross-cut," with one set of dotted lines showing the

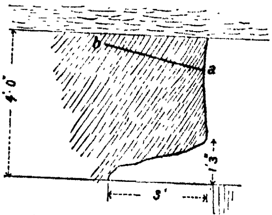


FIG. 72.—SECTION OF A "PLACE," SHOWING POSITION OF SHOT-HOLE, AND KIRVING.

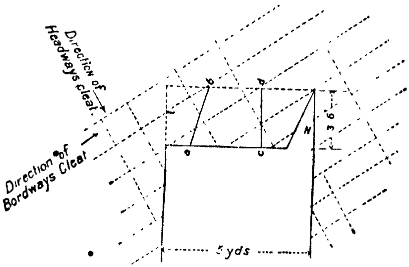


FIG. 73.—SKETCH SHOWING POSITION OF SHOT-HOLES AND NICKING IN A CROSS-CUT.

bordways "cleat," while the other dotted lines at right angles to the bordways show the headways "cleat." Where these cleavage planes or other "backs" or "partings" in the seam run more or less diagonally across the "place," the nicking (N, Fig. 73) should be at that side of the place which forms an acute angle with these "backs," and the shot at the other side. The force of the shot is exerted along these lines, and therefore when they are running into the seam from the shot-hole, more coal is likely to be brought down.

Shot-Firing.—The process of charging and firing a shot in coal —in those mines where the use of gunpowder is admissible—is briefly this:—A hole is bored, about an inch in diameter, and of the same depth as the kirving; the *débris* is cleaned out with the scraper (see Fig. 22); the cartridge or cartridges of powder* (prepared beforehand at the surface) are put into the back of the hole; the pricker (see Fig. 23) is inserted, and the hole is then "stemmed" round the pricker with the "beater" (see Fig. 21) to the out-end of the hole. The "stemming" or "tamping" material is usually either soft clay or seggar (fireclay) crushed up into a more or less powdery condition, small coal being strictly prohibited by the Act of 1887 (see *General Rule* 12). When the hole has been stemmed, the pricker is withdrawn, and either a squib or a straw filled with powder (in the North, termed a "kitty"), with a little touch paper attached to it, is then inserted in the hole made by the pricker. The deputy or hewer then very carefully examines the "place," and parts contiguous to it, and if he discovers no gas, he unscrews his lamp, sets fire to the touch paper, again screws his lamp, and adjourns to a place of safety until the shot explodes.

The procedure just described is the old-fashioned method, which is still followed in many seams making little or no gas. If the mine be one where it is unlawful to unlock a lamp in the pit, other means of firing shots must be resorted to, such as the heating of a copper wire in the flame of the safety-lamp, passing it through the gauze, and lighting up the squib or kitty by means of it. Better than this is some safety igniter, such as Bickford's patent fuse and safety-lighter, which are designed to prevent the emission of either flame or spark, or highly heated gases, and in which the ignition of the fuse is brought about by chemical agency within the appliance after its insertion in the shot-hole. Where there is any danger of firing gas or igniting coal dust, some safety (so-called) explosive ought to be used, and the shots fired by electricity with a low or high tension fuse.

---

* Bobbins of compressed powder are now much used.

Miss-Fires.—Under the Mines Act of 1887, "when a hole has been charged, the explosive shall not be unrammed, and no hole shall be bored for a charge at a distance of less than 6 inches from any hole where the charge has missed fire" (*General Rule* 12).

A considerable time should be allowed to lapse before a miner returns to his working place, in the event of a miss-fire; twenty or thirty minutes not being too long to ensure safety, unless the shots are fired by a detonator and an electric battery.

One of the conclusions in the report (recently issued) of the Explosives Committee of the North of England Mining Institute is that "in the case of a charge of a high explosive which has missed fire, if a short length of stemming (proved up to 8 inches) has been employed, the charge can be detonated by another cartridge of the explosive and additional stemming being placed in the hole in front of the original stemming."

This method of dealing with miss-fires, though hardly to be recommended in fiery or dusty mines, has been carried on for some time with success by Mr J. D. Kendall, in hæmatite mines of the Whitehaven district.* Mr Kendall states in his useful paper that "it is quite unnecessary to put more than 3 to 6 inches of stemming at the most into a hole," dynamite being the explosive used; and also that it is "quite unnecessary to insert the cap (detonator) within the explosive," but that it is absolutely necessary that the shot and the cap should be in contact.

In fiery seams, when shot-firing cannot well be abolished altogether, the safest system is to carry out all blasting operations when the men are out of the mine, by a competent person appointed for the purpose, commencing near the return airway, in each panel, and taking the shots in rotation, so that if gas should be liberated by the first shot, it would not have to pass the next one. It need hardly be added, however, that the carrying out of this system is in many cases inconvenient, and disadvantageous to the economical working of a seam.

Shot-firing ought to be abolished, so far as is practicable, in dusty mines, or in seams giving off inflammable gas. Most of the explosions are due to it. In many mines, however, it can be practised with as little danger as in open quarries.

---

* See *Trans. Fed. Inst. of Mining Engineers*, vol. vii., p. 605.

Whilst dealing with the details of face work, mention may be made of a method known locally in the North as "Sump and Back End." In driving places "on end," or "headways way," both in the whole or broken, after kirving across half the place, and nicking up one side, a hole is drilled about the centre of the place, and a shot fired, which brings down that "sump," as it is called. The hewer then frequently proceeds to take out a similar sump in the same half of the place, thus leaving a "back end," which may be kirved bordways, and brought down altogether by one shot in the right or left "nook" as the case may be (see Fig. 74). In wide places driven "on face," or bordways way, in a similar seam, frequently no nicking is done, but the hewer kirves the place for its whole width, and fires two shots—one in the left nook and the other in the centre—to bring down half the width of coal, and two more shots for the other half.

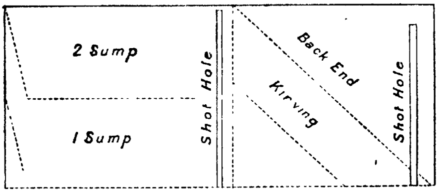


FIG. 74.—SKETCH ILLUSTRATING "SUMP" AND "BACK END."

In working some of the coking seams of West Durham in the whole, in the wide bords the kirving is sometimes made 5 feet in, and the first hole for the "breaking-up" shot is drilled to about this depth—"shooting fast" being allowed and there being no nicking, as round coal is not especially wanted. The diameter of such a shot-hole is usually about 1 inch, but the drills vary from ¾ inch to 2 inches. Sometimes as much as 32 inches of powder= about 1 lb will be fired in this shot; but a more usual quantity is 20 inches = about ⅝ lb. The back-end shot is lighter. The length of shot-holes, and the amount of explosive used, vary according to the nature of the seam, the work required to be done, and the size of coal wanted. Eight oz. of powder is perhaps an average charge.

Ventilation in Panel Working.—There are several ways of ventilating panels when "going in the whole," and those most frequently adopted may be briefly described:—

(1.) *Where the workings are not subject to much gas*—that is, in pits which cannot be termed fiery—the air-current is directed as shown in Fig. 75.

(2.) *Where the seam generates gas* to such an extent that it is

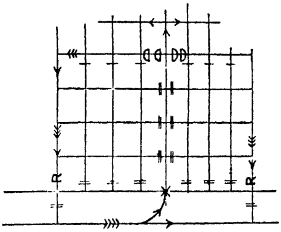


FIG. 75.—PLAN OF VENTILATION IN PANEL (NON-GASSY).

frequently detected by the lamp in the workings—in other words, in mines which are classed as fiery—the mode of ventilation shown in the next diagram, Fig. 76, is usually pursued. In this case, the return air is caused to pass through a regulator fixed in the place next to, and parallel to, the haulage road, so that the air has to

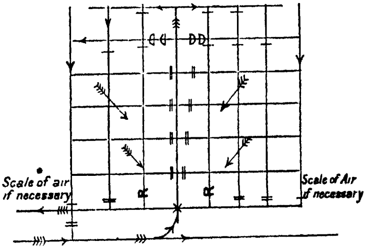


FIG. 76.—PLAN OF VENTILATION IN PANEL (GASSY).

pass through all the old workings before it reaches the regulator and makes its exit into the main return.

(3.) *Where the pit, or part of the pit, is very fiery*, and subject to "blowers" of gas—which may continue to give off large volumes at a high pressure for a considerable time, sometimes not diminishing for years—the system of "shething" or coursing the air to and fro along the passages (as shown in Fig. 77) is adopted. The air is said to be "shethed," or coursed, "one and one," or "tw and two," when it is carried along the top end of a row of pillars and back along the bottom (Fig. 77) of the same row, or along the top of one row and back again along the bottom end of a second row of pillars (as in Fig. 78), respectively. Where the seam in work is exceptionally fiery, it may be necessary, or at any rate desirable, to course the air "one and one," but it will be seldom that such a condition of mine will exist as to render this imperative, and usually in fiery mines it will suffice to course the air every three or four pillars.

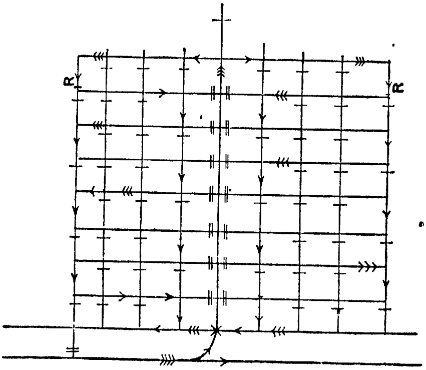


Fig. 77.—Plan of Ventilation in Panel (Very Fiery).

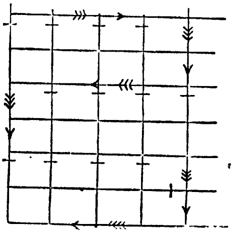


Fig. 78.—Plan of Ventilation in Panel (Very Fiery: Coursing Air Two-and-Two).

A Practical Example.—Where the bords and walls soon become filled with fallen stone, or where districts are subject to creep and thrust, and it is therefore desirable to work out the coal as soon as possible, the pillars are removed soon after they have been formed—or, as the expression is, "the whole is followed up by the broken." This manner of working is shown in the accompanying diagram, Fig. 79, Plate XXIV. The broken is aired with the current from the whole workings, and the scale on the doors *a a*. The sketch represents varied circumstances which are encountered in bord and pillar workings, as indeed in other methods also, and which tax the judgment and the ingenuity of the colliery manager. The information which it is intended to convey may be conveniently expressed in the form of question and answer, the question being of a type commonly occurring in the examinations for colliery managers' first-class certificates.

Given, then, that the seam is 4 feet thick, and free from intervening bands; that the roof and thill are fairly good, requiring only ordinary timbering; that the position of old goaves, and the issue of gas, are as shown on the plan. Mark on the plan the position of the landings and putters' "flats," and state the volume of air required in each split, denoting the air currents by arrows, brick stoppings by double lines, brattice stoppings by single lines, doors thus, D; scales thus, S; regulators thus, R; and air-crossings by an X. State also the number of hewers per shift, the tons per hewer per day, and the number of deputies required, the hewing price per ton being 1s.

The answers will be as follows, and as shown on Fig. 79, Plate XXIV. Amount of air in splits:—

	4,000	cubic feet	per min.
	6,000	„	„
	5,000	„	„
	2,000	„	„
	1,000	„	„
Total ...	18,000		

Number of hewers per shift, 30; total number, 60; average hewers' wage per shift, 5s., to earn which the average tons per hewer per shift must be 5, and the tons per day 300; number of deputies, 3 per shift = 6 total.

In connection with the mode of working "following up the whole with the broken," attention should be given to the necessity of keeping an airway, of such dimensions as will permit it to be easily travelled by the officials, from the last working place in the whole to the commencement of the broken, and from the last broken working to the main return airway for the district.

Stoppings.—The bord-end stoppings are usually made of wood brattice. They keep the air on to the face. The permanent main stoppings alongside the rolleyway, and the "regulator" stoppings—or the stoppings which direct the air on to the regulator, and which are in a line with it, and are moved forward when it is advanced—are best constructed of stone or bricks, well plastered over with hair and lime to make them air-tight.

The Position of the Regulator is an important factor in the practical ventilation of colliery workings. As a general rule, in panel workings such as we have described, it should be as near the face as is conveniently practicable, as by so placing it the air pressure on the haulage road (intake) stoppings is greater than if the regulator were placed on the outbye side of these stoppings. For the same reason it is desirable to have the return airways skirting the haulage (intake) road on either side, one pillar distant, so that any gas issuing from the old workings may pass into these airways and be swept away by the return air into the main returns, and that there may be no risk of gas leaking through the stoppings on to the intake airway. A "scale," if any, is usually placed in the furthermost corner of the panel next the main return, so as to act as a drain or gas-tap to the old workings.

Fire-damp being lighter than air, it naturally rises to the highest workings of a district. In mines subject to much gas, this is often a source of considerable inconvenience, especially if other circumstances are such as to necessitate the workings being driven to the dip. In such instances it is often found desirable to have a gas-tap (Fig. 67, page 160)—that is, an outlet—at the highest possible point of the workings; and if these are coming back in the broken, this passage should be kept open up to, and for some distance into, the old workings, so as to act as a relief to the pressure of gas accumulating in them. This mode of drawing off the gas is known as "ascensional" ventilation.

Fig. 80, Plate XXV., represents a set of two panels, both in course of being brought back in the broken. The diagram is taken from an actual colliery plan of a Durham mine, with the addition that the skirtings, juds, &c., are shown in detail.

When working in the whole, the air was conducted along the face by means of wood brattice, which was fixed by the deputies to the props. Sometimes a row of props had to be set specially for the brattice. It ought to be kept within a few yards of the face, and the joints in fiery pits should be well pointed with lime or "cleaded" with strips of wood, as it is astonishing what a quantity of air may be lost and never reach the face when this is not carefully done. A place fouled with gas may sometimes be cleared by merely pointing the brattice and making it air-tight. Another matter requiring attention is the canvas doors at the place ends, which force the air up the brattice.

The workings shown in Plate XXV. are in a seam of which the following is a section:—

	Feet.	Inches.	
Top coal	1	6	Unworked, being inferior coal.
Good coal	3	6	Worked; but running through the middle is a band of grey coal 5 inches thick, together with a band of stone 1 inch thick, which are cast back.
"Slippery" band, on which the men kirve	0	1	Picked out and cast back.
Good coal, which is taken up after the main or middle part of the seam is wrought	0	6	Worked.
Bottom or steam coal ...	1	0	Worked.
Total thickness of seam	6	7	

The seam dips 1 in 18 to the east, and is, at the shaft, 147 fathoms from the surface. The roof is generally of soft sandstone; but the top coal, being left, forms a fair support when working in the whole. The thill is a bed of sandstone similar in quality to that forming the roof. The pillars are made 44 × 44 yards, centre and centre. The character of the coal, when going in the whole, is decidedly strong, which is a frequent characteristic of the seam in question.

When a flat, or panel, has reached the determined distance, broken working is commenced at the two extremities, the pillars being removed on some regular plan, and a proper (diagonal) line of advance kept, so that no pillar, or portion of a pillar, is left surrounded with goaf. Neglect of this precaution would cause some of the coal to be crushed and lost. As all bords and walls have fallen, the pillars are skirted along the bottom end for a "going headways," and the pillars either judded to the rise the full breadth —40 yards—the last jud being shortened by a lift driven so far along the top end of the pillar; or the pillar is jenkined up one side, skirted along the top end, and juds driven half-way down, the other half of the pillar being taken off by judding from the bottom end.

In order to work the barrier, a skirting (*a*) is driven south along the bottom end of the row of pillars next to be worked until it reaches the barrier, and so serves in the future as a place from which juds may be driven; the barrier is then jenkined (*b*) down by the side, and a narrow place (*c*) driven into the solid through the barrier (provided it be of convenient width: if it be too wide, it is worked from both districts), and juds (*d*) turned away to the east and west—those going westward holing into the barrier goaf, and those turned away to the east being driven the required distance, whatever it may be.

In working in the broken—where the roof is composed of soft shale, and apt to "come on" or "weight," however well timbered the place may be—when a pillar has been removed by judding, excepting the last jud, it is not unusual, especially when the pillar happens to be the one next to the waggon way, to take off this last 5 yards, or the width of a jud, by a series of headways lifts, that is, places about 5 yards wide driven in a headways direction in a pillar from the waggon way—for if it were attempted to take it off by a bordways jud, it would most certainly break down.

When a jud does fall, the method usually adopted of again reaching the face is seldom that of ridding out the fallen jud, as the cost of so doing would far exceed that of the lost timber and rails. It would be "dead work," no coals being obtained in the operation, besides the loss caused by having to send out stones in the tubs, instead of coals, if the stones could not be stowed in the workings. But a narrow place is turned away, and the fallen jud skirted or jenkined, as the case may be, "loose at an end," until the termination of the fallen jud is reached, when a "siding-over" is driven 5 yards across the face, and the jud continued.

The following is a list of the yard prices paid at this pit:—

WHOLE WORK.

			s.	*d.*	
Winning headways	2 yards wide	... ...	1	10	per yard.
Walls, N. & S.	2 ,,	... ...	1	9	,,
Winning headways	3 ,,	... ...	1	3	,,
Walls, N. & S.	3 ,,	... ...	0	6	,,
Bords	2 ,,	... ...	1	4	,,
Do.	3 ,,	... ...	0	10	,,
Boring ..	... ...	... ...	0	10	for 10 yards.

PLATE XXV.

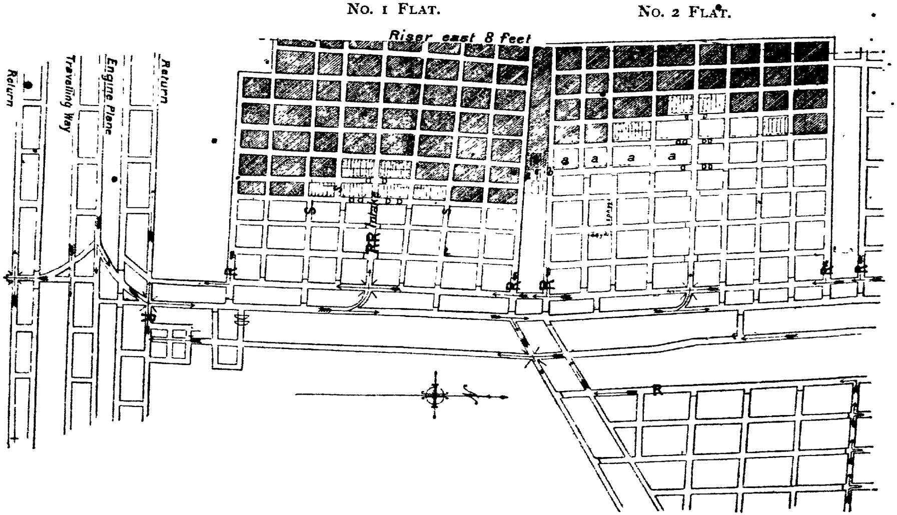


Fig. 80.—Plan of Broken Workings, Bord and Pillar System.

REFERENCES.—Shaded part, goaf; Air-crossing shown thus, X; Regulators, R; Doors, D; Stoppings, —; Air-Scales, S; Arrows denote direction of air-currents.

[To face page 172.

BROKEN WORKING.

				s.	*d.*	
Half pillar walls	2	yards wide	... ...	0	11	per yard.
Do.	do. 3	,,	... ...	0	7	,,
Skirtings	2	,,	"loose at an end"	0	7	,,
Jenkins ...	2	,,	"fast at both sides"	0	9	,,
Do. ...	...	...	"loose at an end"	0	7	,,
Removing stooks	...	...	... ...	0	10	per stook.

The score price for hewing in the whole was 12s. 6d. for 21 tubs of 11 cwts. each = 13d. per ton. The broken price was 9s. 5d. = 9¾d. per ton.

In working the barrier dividing the two districts, a communication is effected between them, so that the question arises—Which way will the return air of either district take? Will it pull from the first to the second, or *vice versâ?* If no definite precautions are taken to keep it in one direction, it might, if there were heavy falls, or obstructions of any kind, in the returns of No. 1 flat, pull from this district to No. 2 district, carrying the gas with it from the goaf edge if there were a low barometer, and so foul all the workings in No. 2 flat which it passed. In order to avoid this, the following steps will suffice:—Put two* regulating doors, R R, in the intake of No. 1 flat, the area of which let us suppose to be 7 square feet each, the regulator in the north side return being 10 square feet area, so as not to materially check the efflux of the return air. The regulating doors on the intake of No. 1 district will act as a check on the air passing through the apertures at a high velocity, and against a corresponding resistance, but in the north side return there is less resistance and an easy road. Now, as there is no obstruction offered to the intake air of No. 2 district, there will be a considerable volume passing in it more than in No. 1 flat; and as the regulator in the north return of No. 1 is capable of passing a much greater volume of air than would be supplied to it from No. 1 alone, a portion of the air from No. 2 will pass through the barrier, and down the north side return of No. 1, through the regulator there and into the main return, and may always be depended upon keeping to this road.

In fixing the regulators in No. 1 intake, the better way is to make a separate place for them from off the waggon way, as represented at R R, in Fig. 81, so that they may be clear of the constant traffic of the waggon way, on which two "fast" doors, D D, would have to be fixed.

---

* Two, because when one is open for the passage of men or tubs, the second still acts as a check.

Old Manner of Winning and Working Pillars.—We are often inclined, in considering the mining methods adopted by our forefathers, to blame them for their shortsightedness in working on what seem to us such wasteful and ruinous systems; but when we bear in mind what were the actual conditions of the primitive state of coal-mining, including the want of any form of safety-lamp, the impossibility of securing good ventilation with the simple appliances and limited experience then available, and the like hindrances, we are bound to admit that they did fairly well under the circumstances.

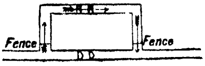


Fig. 81.—Mode of Regulating Intake Air.

Figs. 82 and 83 illustrate some of the early methods of laying out pillars. The pillars were left very small, in order that as large a percentage of coal as possible might be obtained in winning out the pillars, which were then abandoned. The pillars were 15 yards long; the walls 2 yards wide; the bords being turned away out of the headways 3 yards wide, and gradually widened out until at the middle of the pillar, where the coal left between was very thin—in fact the bords often holed into each other

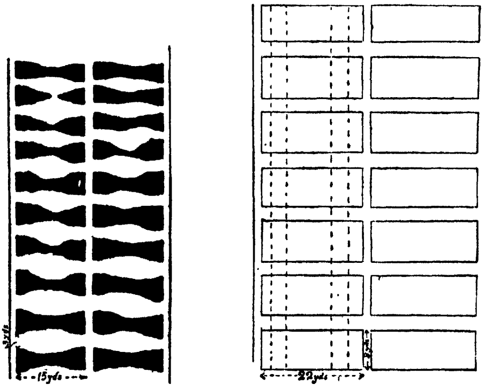


Fig. 82. Fig. 83.

Diagrams illustrating Old Pillars.

(see Fig. 82). The bords were then narrowed in as they approached the wall, and holed 3 yards wide as at the other end, and so protected the headways course. In some cases the pillars were 20 yards long, and 5 or 6 yards wide, and driven straight. The pillars so formed were abandoned, an enormous quantity of coal, amounting sometimes to 35 per cent., being thus sacrificed. Sometimes a system of reducing the pillars was adopted, and in cases where pillars had been left 12 by 9 yards and 22 by 8 yards, or in some other sufficiently large dimensions, they are known to have been partially removed by driving a wide place through the middle of the pillars, or by driving a place at the top and bottom (see Fig. 83).

As already explained in Chapter I., when pits got deeper, this mode of working could not be carried on to any great extent without producing the serious consequences of creep or thrust. These were very frequent and disastrous in their results at the commencement of the present century, whole tracts of coal being thus entirely lost. As time progressed, however, and a greater amount of knowledge was gained through experience, mines were laid out and worked differently.

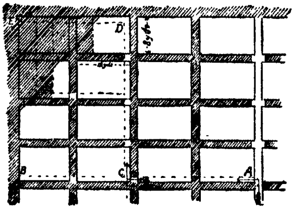


FIG. 84.—METHOD OF REMOVING OLD PILLARS.

In a district which had been worked in the whole many years ago, the pillars had been left 12 yards long and 8 yards wide, in a seam lying at a depth of 300 yards from the surface, and dipping 1 in 18, with a thickness of 4 feet 3 inches. The thill was seggar (fireclay), and the roof was composed of 2 feet of soft blue stone (shale), above which was a hard "grey metal" (arenaceous shale). When removing the pillars in this district the coal was most expensive and difficult to work, the roadways requiring constant lowering, and the coal was very much broken. Various methods were tried in working off the pillars with more or less success; but

as it was found most economical to have only a few hewers in the district, and to keep open at one time as few roadways as possible (the headways and bords which had been driven respectively 2 yards and 5 yards wide, were all close fallen), the following was found to be the most satisfactory method of procedure. As shown in the illustration (Fig. 84), a skirting, A B, 2 yards wide, was driven from the rolleyway at four pillars or so back from the face to the far side of the panel, and about two pillars from the far side, a jenkin, C D, 2 yards wide, was driven to the goaf. A skirting, D E, 3 yards wide, was then driven along the goaf side to the far end of the second pillar, and juds were then commenced. The adjacent pillar was then skirted along the other end, thus leaving a larger distance between the skirtings, and so two pillars were brought back together. For timbering ordinary props were used, which were drawn out when each jud holed.

(see Fig. 82). The bords were then narrowed in as they approached the wall, and holed 3 yards wide as at the other end, and so protected the headways course. In some cases the pillars were 20 yards long, and 5 or 6 yards wide, and driven straight. The pillars so formed were abandoned, an enormous quantity of coal, amounting sometimes to 35 per cent., being thus sacrificed. Sometimes a system of reducing the pillars was adopted, and in cases where pillars had been left 12 by 9 yards and 22 by 8 yards, or in some other sufficiently large dimensions, they are known to have been partially removed by driving a wide place through the middle of the pillars, or by driving a place at the top and bottom (see Fig. 83).

As already explained in Chapter I., when pits got deeper, this mode of working could not be carried on to any great extent without producing the serious consequences of creep or thrust.

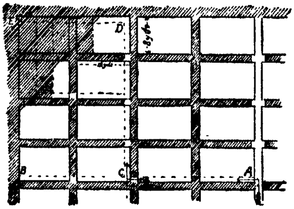


FIG. 84.—METHOD OF REMOVING OLD PILLARS.

These were very frequent and disastrous in their results at the commencement of the present century, whole tracts of coal being thus entirely lost. As time progressed, however, and a greater amount of knowledge was gained through experience, mines were laid out and worked differently.

In a district which had been worked in the whole many years ago, the pillars had been left 12 yards long and 8 yards wide, in a seam lying at a depth of 300 yards from the surface, and dipping 1 in 18, with a thickness of 4 feet 3 inches. The thill was seggar (fireclay), and the roof was composed of 2 feet of soft blue stone (shale), above which was a hard "grey metal" (arenaceous shale). When removing the pillars in this district the coal was most expensive and difficult to work, the roadways requiring constant lowering, and the coal was very much broken. Various methods were tried in working off the pillars with more or less success; but

of about 3 feet. When this road had been driven to the far end of the pillar, a "lift," 6 yards wide, was turned away next to and parallel with the headways. It was found that the coal yielded a larger produce of round when worked in a headways direction or "on end." Five of these 6-yard lifts completed the pillar.

Fig. 86 shows a system followed at Marley Hill colliery, West Durham district, in removing pillars in the Busty Bank seam, which is 144 yards deep at the shaft, and averages in section 5 feet, including two stone bands, 4 inches and 1½ inches thick, about the middle of the seam. The pillars are 50 yards bord by 20 yards wall. They are split by a siding-over or half-pillar wall, C D, driven through the middle, and are worked off in bordways lifts, 5 yards wide, right and left from the split wall and from each headways course.

The same system is followed at Byermoor colliery in the West Durham district, in working pillars 50 × 33 yards, centre and centre, in the Busty, which here varies in thickness from 4 feet 6 inches to 9 feet, including a band of fireclay. The seam is 130 yards deep at the shaft.

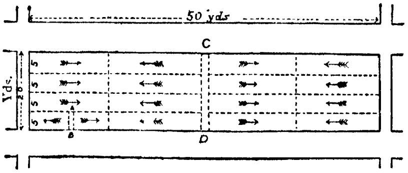


FIG. 86.—METHOD OF WORKING PILLARS AT MARLEY HILL.

This system is also followed at the Towneley colliery, Emma pit, North-west Durham, in removing pillars 20 yards square, in the Brockwell seam. Its depth is 168 yards, with section as follows:—

	Ft.	In.	Ft.	In.
Coal	0	2½	...	
Band		...	0	1½
Coal	2	6½	...	
	2	9 +	0	1½ = 2 ft. 10½ in.

In this case it is not necessary to split the pillar by a half-pillar wall, but the lifts can be carried up half the length of the pillar, or 10 yards. Sometimes in getting the last lift the roof would not stand if the lift were driven 10 yards up from the headways, and

(see Fig. 82). The bords were then narrowed in as they approached the wall, and holed 3 yards wide as at the other end, and so protected the headways course. In some cases the pillars were 20 yards long, and 5 or 6 yards wide, and driven straight. The pillars so formed were abandoned, an enormous quantity of coal, amounting sometimes to 35 per cent., being thus sacrificed. Sometimes a system of reducing the pillars was adopted, and in cases where pillars had been left 12 by 9 yards and 22 by 8 yards, or in some other sufficiently large dimensions, they are known to have been partially removed by driving a wide place through the middle of the pillars, or by driving a place at the top and bottom (see Fig. 83).

As already explained in Chapter I., when pits got deeper, this mode of working could not be carried on to any great extent without producing the serious consequences of creep or thrust. These were very frequent and disastrous in their results at the commencement of the present century, whole tracts of coal being thus entirely lost. As time progressed, however, and a greater amount of knowledge was gained through experience, mines were laid out and worked differently.

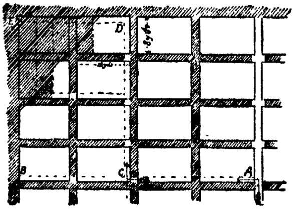


FIG. 84.—METHOD OF REMOVING OLD PILLARS.

In a district which had been worked in the whole many years ago, the pillars had been left 12 yards long and 8 yards wide, in a seam lying at a depth of 300 yards from the surface, and dipping 1 in 18, with a thickness of 4 feet 3 inches. The thill was seggar (fireclay), and the roof was composed of 2 feet of soft blue stone (shale), above which was a hard "grey metal" (arenaceous shale). When removing the pillars in this district the coal was most expensive and difficult to work, the roadways requiring constant lowering, and the coal was very much broken. Various methods were tried in working off the pillars with more or less success; but

then made, and the full width of face, 12 yards, E, is lifted off to the headways. The remaining blocks, F, F, are brought back together. Formerly these pillars were worked by driving one jenkin up the centre for 24 yards, siding-over right and left and taking the end off, and then bringing back the two wings together.

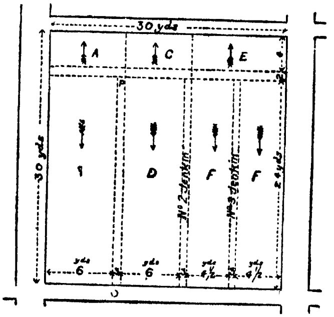


FIG. 88.—METHOD OF WORKING PILLARS AT OLD PONTOP.

This was abandoned on account of the expense of timbering, though the coal was successfully got; and the present method, as above described, was adopted in preference.

The following plan was adopted at Killingworth colliery,

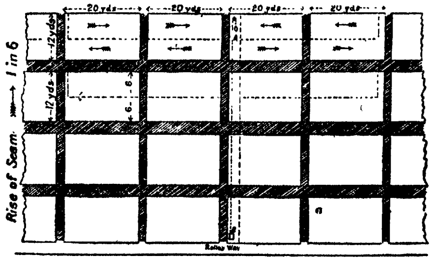


FIG. 89.—METHOD OF WORKING PILLARS AT KILLINGWORTH.

Northumberland, in working a district of pillars in the High Main seam, where it lay at a considerable inclination—about 1 in 6. The seam is 226 yards deep at the shaft, and was in this district 6 to 8 feet in section of excellent coal, being the same seam as that which used to be worked at the old Wallsend colliery, on the bank of the Tyne, and of the quality which has made Wallsend so famous amongst house coals in the London market. The pillars were 20 yards bord by 12 yards wall. The old bords and headways were generally fallen. Fig. 89 shows the method of working, the arrows denoting the direction in which the lifts were worked. A skirting, A B, was driven by the side of the old headways up the rise of the seam (leaving a thin shell of coal on here and there, sufficient to prevent the fallen stone from running in), to the extremity of the area to be worked. This skirting was well timbered, and laid with double way to be used as a "dilly." (A dilly is the local term for a self-acting incline worked with a light chain running round a small sheave, which is tethered by a short length of strong chain to a stout prop placed at the top of the incline. This sheave can be readily moved, so that there is little difficulty in lengthening or shortening the incline. Formerly a hemp rope and a counterbalance weight were used, but a chain in place of the hemp rope, and a full tub in place of the weight, are a decided improvement. It is usually run with one full and one empty tub at a time, and the lad at the top controls the speed by placing an iron "sprag" between the spokes of the sheave.) The dilly having been made, places were turned away, and driven 6 yards wide in the farthest up pillar, right and left from the dilly. These places were continued through two or sometimes three pillars, and then the remaining 6 yards were brought back towards the dilly. As a rule a dilly was made next every fourth headways course, and 16 pillars worked to each.

At another part of the High Main seam workings at Killingworth colliery, some 2 miles distant from the former, the seam was lying nearly level, and the section was:—

	Ft.	In.	Ft.	In.
Top coal	0	6	...	
Stone		...	0	1
Bottom coal	4	5	...	
	4	11 +	0	1 = 5 ft.

The top stone was very bad, being loose and rubbly, with no sound parting for some way up. The pillars were made 30 yards bord by 18 yards wall (see Fig. 90). A skirting having been made by the side of the headways, two jenkins, each 5 yards wide (A and B, in Fig. 90), were set away, and driven simultaneously up the full length of the pillar. The more quickly a pillar can be removed the better, especially when the top stone is troublesome. The farthest inbye of the two jenkins was then "drawn"—that is, the rails, and as much of the timber as possible, were removed—and allowed to fall, thus relieving the pressure, the other jenkin being kept open to form the road out for the rest of the pillar. This was, if possible, brought back in one lift to the headways. As a rule, however, the top stone was too bad to admit of this being done, and in this case a lift, C, would be taken 10 yards up, or as far as the stone would allow, and then D would be worked off. A siding-over, O P, would then be made about the middle of the remaining block of coal in order to shorten the length of lifts, and these would be got in the direction shown by the arrows, E and F being first removed, and then G and H.

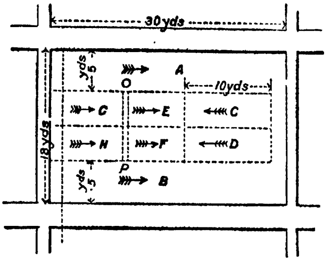


FIG. 90.—ANOTHER METHOD OF WORKING PILLARS AT KILLINGWORTH.

A large area of the High Main seam in the neighbourhood of the Ninety-fathom * dyke, towards which the seam dipped heavily, was successfully and economically worked as follows:—Headways were driven up the full rise of the seam, at intervals of 33 yards apart, to the extremity of the district, a length of about 250 yards. Holings between them were made every 50 yards. After the headways had been driven to the extremity the pillars were brought back, being worked in bordways lifts right and left from each headways course, and driven half way up the pillar. The headways were driven "under the top," and used as self-acting inclines.

---

* One of the principal geological dislocations of the coalfield—a downthrow north—often much exceeding 180 yards, and running from the sea-coast at Cullercoats westward by Gosforth and Denton to Greenside and Whittonstall.

A similar plan was very successfully carried out in working the Main Coal seam at Houghton colliery, County Durham. The section of seam averaged 7 feet of coal. A large area of it was laid out in blocks 100 × 80 yards, by narrow places, 2 yards wide, driven to the boundary, with holings between them for ventilation at intervals of 100 yards. The seam made a good deal of gas, and the narrow places were bratticed by a plank brattice well pointed with lime. The boundary having been reached, the blocks of coal were worked back in one face bordways on the longwall principle, three rows of props being kept next the face. The working cost of underground labour and screening was below 2s. a ton.

A seam of tender coal known as the Three Quarter—2 feet 2 inches in thickness, at a depth of 70 yards, with a hard roof and floor—is being worked as follows:—The pillars are made 24 yards square, and the first working followed up closely by their removal. The headways are driven 3 yards wide, in order to make room for the stowing of the bottom stone, which is taken up for a width of 1 yard to make height for the "way," the remaining 2 yards being filled with the bottom stone. In working the pillar, a jenkin (A B, see Fig. 91) is driven half way down the centre of the pillar, then sidings-over, B C, B D, to the bord at each side, and then the rest of the coal is got in bordways lifts to the sidings-over, and the headways. The "way" on the headways is thus utilised in working the pillar, and no ridding of fallen stone is required in order to get at the pillar. The hewing price in the whole is 1s. 2d. a ton, which includes the cost of taking up bottom stone to make height for the tub; in the broken it is 1s. 1d. a ton.

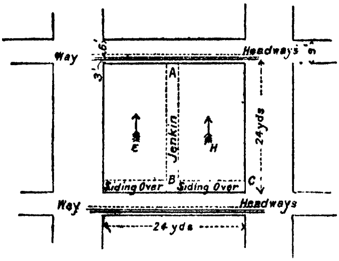


FIG. 91.—METHOD OF WORKING PILLARS AT GARESFIELD.

II. At Depths from 300 to 600 yards from Surface.—At

Castle Eden colliery (now closed), in the East Coast district of the county of Durham, pillars 33 yards by 22 yards, in the Low Main seam, were worked on the method of bordways lifts. The seam was 3 feet in section where thus worked, though it was much thicker than this in other districts of the colliery. The roof was a strong "post" or sandstone, which stood well. Depth, 300 yards. The two first lifts in the pillar were made 8 yards wide, leaving 6 yards for the last one, and they were carried up the half pillar or 16½ yards. The way was laid up the middle of each lift, chocks being built on each side at intervals of 3 feet apart. These were subsequently removed without much difficulty, as the top stone frequently did not fall for some time after they had been drawn. Sometimes these pillars were worked by driving a jenkin by the side of the old bord where it was fallen, and removing the remainder of the pillar in headways lifts, as little or no difference was found in working them, whether this way or bordways.

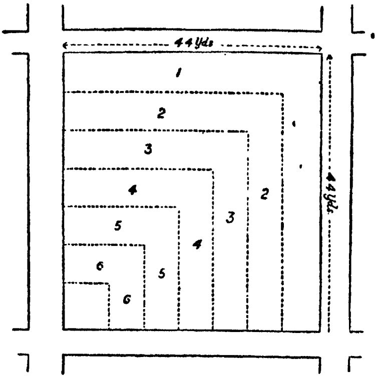


FIG. 92.—METHOD OF WORKING PILLARS AT MURTON.

The plan of bordways lifts is adopted at Silksworth colliery (East Coast district, Co. Durham) in working the Maudlin and Hutton seams; the former lying at a depth of 536 yards at the shaft, 5 feet 9 inches in section, and the latter at 580 yards, 4 feet 6 inches in section.

Fig. 92 shows a method followed at Murton Colliery, in the same district, in working pillars 44 yards square in the Hutton seam.

Depth at the shaft 490 yards, with a section of good coal 3 feet 10 inches, and bottom coal 10 inches, which is removed to make height. Bordways and headways lifts are driven simultaneously. No narrow work is required, and the square shape of the pillar—the best shape for resisting pressure—is retained, whilst it is being reduced in size.

The following example is taken from the Main Coal seam at Eppleton colliery, in the county of Durham, lying at a depth of 346 yards from the surface at the shaft, and having the following section:—

	Ft.	In.	Ft.	In.
Top coal unworked	...		1	6
Good coal worked	4	4	...	
Bottom coal „	0	9	...	
	5	1 +	1	6=6 ft. 7 in.

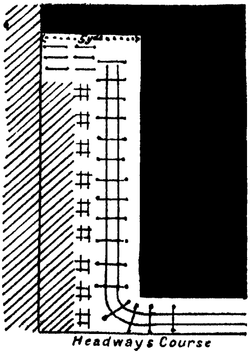


FIG. 93.—THE TIMBERING OF A JUD.

The pillars had been laid out 44 by 33 yards, centre and centre, the headways driven 2 yards and the bords 5 yards wide. It was not found necessary to skirt the headways, as there was only the top coal fallen, the roof being a strong grey metal (arenaceous shale), and the thill also strong. The wide bords, however, fell, so that these were jenkined (loose) for a going bord, the headways being ridded out. The juds were driven to the rise the width of the pillar from out of each headways, the timbering being carried out as shown in Fig. 93. The juds were driven 5 yards wide, and chocks built with oak logs, 22 by 4 inches, were set 6 feet from the coal side, and 4 feet 6 inches apart. The mainway was timbered where necessary with props and planks, as shown in the sketch; the space between the chocks and the loose side of the jud was also timbered with props and planks, but these were drawn out every night, three rows being always left next the face, and the roof allowed to fall behind them.

This system has been adopted wherever possible, as a great saving in timber is the result, the props being recovered and not

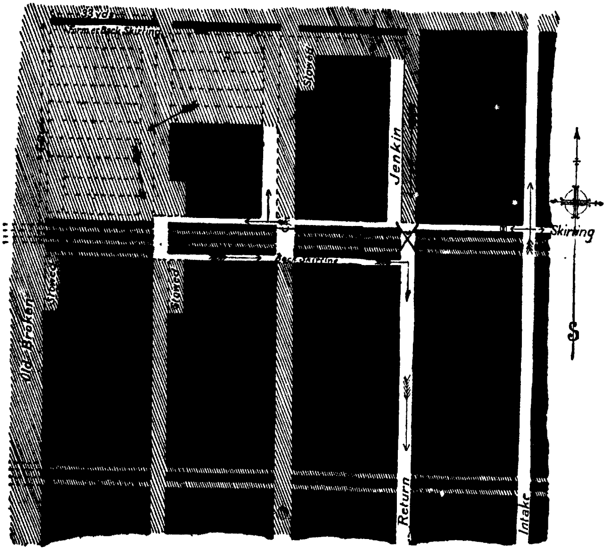


FIG. 94.—METHOD OF WORKING PILLARS IN THE HUTTON SEAM AT EPPLETON.
Scale, ½ inch = 1 chain.

standing until broken, or stowed up, as is often the case. The chocks are drawn when the jud holes—that is, is driven its full distance. The pillars are of good size for satisfactory working, yielding a good percentage of round coal—viz., about 60 per cent. The timbering is carried out by deputies, who build the chocks and alter any timber which is set by the hewer if required. In the absence of the deputies, the hewer himself sets it if wanted. The back timber, or timber between the chocks and the loose side of the jud, is drawn by two timber drawers, who are sent into each pit at night for the purpose, and who draw all the broken districts in the pit.

The seam from which the two following examples are taken is the Hutton, an average section at the pit under consideration being—

	Ft.	In.
Good coal	3	0
Bottom coal	0	3
Splint coal	0	3
Total	3	6

The roof consists of shale, varying up to 4 feet in thickness, and above this is a bed of strong white sandstone. The thill is a bed of seggar or fireclay, about 21 inches thick, of excellent quality for manufacture. The seam at the shaft is 346 yards from the surface, and dips east at the rate of about 1 in 20, and at the district from which the first example is taken the depth would be about 450 yards.

As shown in Fig. 94, the pillars are 66 yards by 33 yards from centre to centre, and the longer length (66 yards) is in the headways direction—that is, north and south, contrary to the usual way. The walls (north and south) were driven 5 yards wide, and the bords (east and west) 3 yards wide. The ordinary method was thus exactly reversed. The roof in this part of the pit was very bad, and when working in the whole it was exceedingly difficult to keep it supported with timber until the holings were made. When a holing had been effected, it was found much cheaper to draw the timber all out and allow the roof to fall freely, and then drive another "fast" place alongside, leaving 6 feet of coal next to the drawn-out place. This second place was driven 2 yards wide.

When this district was "going in the whole," it was at the same time "followed up with the broken" on the west side. This is designated the "Old Broken" on the plan, Fig. 94, to distinguish it from the new goaf.

The method of working off the pillars is this:—A skirting (see Figs. 94 and 95) is turned off the waggon way, and is driven (fast) alongside the old walls to the south of the row of pillars, four in number, to be removed. This skirting is driven 2 yards wide, and about 6 feet of coal is left between it and the old walls. Jenkins 5 yards in width are driven from out of the skirting up by the side of the old bords, the remaining portion of the pillar being "judded" off to the west. In order to secure the proper ventilation of the workings, a back or return skirting is driven 2 yards in width, communications (or "stentons") being made between it and the intake skirting. In driving this skirting the bottom has to be taken up, and "places," 5 yards in width, are driven from the

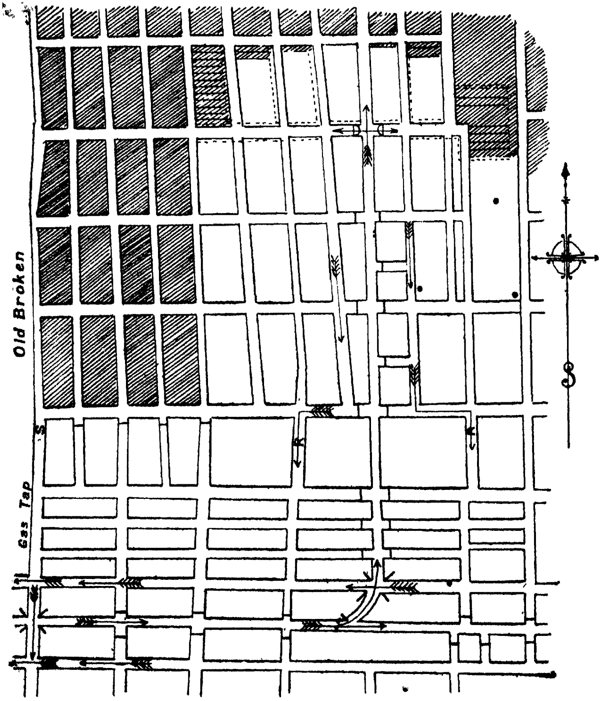


FIG. 95.—GENERAL PLAN SHOWING BROKEN WORKINGS.

References.—Shaded part represents goaf; Air-crossing shown thus, ↘↙ ↗↖; Regulators, R; Doors, D; Stoppings, —; Air-scale, S; Arrows denote direction of Air-currents.

skirting into the solid, for the stowage of the seggar taken up by the bottom cutters to make height. Sometimes when the roof stands badly, a second jenkin is driven, the first is drawn out and allowed to fall, relieving the pressure on the second. The juds are driven for 27 yards or so to the west, the original breadth of the pillars being 33 yards; but 6 yards must be deducted for the breadth of the jenkin. The last three juds or so are shortened by means of a headways lift driven up the west side of the pillar. All lifts and juds are driven 5 yards wide, and no stooks are left, owing to the difficulty experienced in working them off when the jud is drawn.

As regards the ventilation of the workings—which is very important, as the seam makes much gas—it will be best to give two examples: one to demonstrate the manner in which the air is conducted before the completion of driving of the back and other skirting, and the other to indicate the course of the air after these skirtings are driven.

Supposing then, that the intake skirting has not as yet holed into the "old broken," but has only been driven three and a half pillars along, and several juds have been taken off the north end of the fourth pillar—that is, the pillar next to the "old broken"—and that the back skirting has also not yet holed into the goaf; the air would, in this case, be forced along the intake skirting and up the jenkins ventilating the juds, and thence into the goaf, travelling along the last or old back skirting, which will not yet have fallen close, and will pass down the return bord over the intake skirting, at which place a temporary wood crossing is built, and into the main return. But if, on the other hand, the skirtings have holed into the "old broken," the air will pass along the intake skirting, up the jenkins (ventilating the juds), along the edge of the goaf, and down by the side of the "old broken" into the back skirting, and thence into the main return of the district.

As already stated, opposite every jenkin there is a communication between the two skirtings, through which the air is prevented from passing by brattice stoppings, with manholes covered with canvas flaps. At a future date, when the pillars are worked off so far, these will in succession form a road for the return air into the back skirting.

This system of pillar working and of ventilation was found necessary, owing to the quantity of gas evolved from the goaf, and owing also to the effects of creep and bad roof. As it is, there is a considerable amount of "lowering" necessary, owing to the constant lifting of the bottom. Before the flat was ventilated as described above, the gas used to be frequently detected on the tramway, and in considerable volume too.

Fig. 96 represents the barrier workings in this district, or rather the working of the barrier which separates this district from the adjoining one. The operations may be thus described. A fast skirting (*a*) is driven from the tramway towards that portion of the barrier which it is desired to remove. On reaching the barrier a "fast" skirting (*b*) is driven north and south for about 30 yards each way. From the north end of the skirting a "fast" jenkin (*c*) is driven east by the edge of the barrier goaf—that is, that portion of the barrier already worked. From the south end of the skirting another place (*d*) is similarly driven through the solid coal. From the far ends of both these places so driven, a lift (*e*) is turned away, and driven 5 yards wide. These lifts hole half-way, and form a road for the air, the timber being drawn out as soon as a holing has been effected. The rest of the coal is taken out by juds, as shown in the illustration. It will be also observed, on referring to Fig. 96, that there is a back skirting driven from the main return (east side of district), and communicating with a jenkin driven loose by the side of the old headways bord. The use of this back skirting has been already described. The dimensions of the various roads,

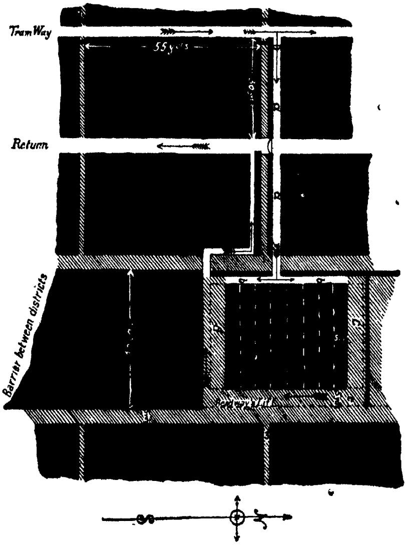


FIG. 96.—BARRIER WORKING IN THE HUTTON SEAM AT EPPLETON COLLIERY.
Scale, ½ inch = 1 chain.

pillars, &c., are shown in the illustration. The remarks as to the necessity of the above mode of working off the barrier, which were made at the close of the description of the removal of the pillars in this district, are applicable here also.

The total quantity of coal produced per annum in the whole of the district referred to averaged about 10,712 tons, the percentage of round coal being 47.38. This is a fair result for the Hutton seam in that part of the Northern coalfield. Subjoined are the costs per ton for the various kinds of labour and other outgoings (December 1885):—

	s.	d.	
Hewing 10,712 tons of coal	1	5.23	per ton.
Deputy work	0	3.45	„
Ridding	0	1.71	„
(Ridders and chockmen draw all juds.)			
Bottom cutting	0	2.74	„
Timber	0	2.61	„
Cost per ton ...	2	3.74	„

The number of cubic feet of air entering the district per minute was about 6,600.

Fig. 97 represents in detail the manner in which large pillars, 66 × 44 yards in the Main Coal, are extracted when the character of the roof of the seam does not allow of much length of jud being driven. The pillars might be worked off by headways lifts being driven the full width; but the quality of the coal so produced would be inferior to that produced by working bordways way. The pillars are skirted along the bottom end, and the pillar to be worked jenkined up its full length, and a skirting driven along its top end, the pillar being judded from this skirting for a distance of about 22 yards. The two last juds are driven up instead of down, a narrow place being set into the solid about 20 yards from the top end of the pillar, and driven 10 yards—the width of the two juds. A skirting is driven (loose) alongside the fallen juds, and the same course of operations pursued until the pillar is entirely removed. All jenkins and skirtings are, of course, driven narrow. The Main Coal in this district is the same, or nearly the same, in section as that given at page 185. The top coal is not worked, but allowed to stand in order to form a roof, the stone above being, as already stated, of a very broken nature.

Recapitulation.—To sum up the question of working-off pillars, it may be said that the system most in favour, and most generally adopted, is that of bordways lifts (right and left from every headways course driven half-way up the pillar), or where the pillars are long (that is, 40 or 50 yards), by first driving a "half-pillar wall" across the middle of the pillar, and carrying the bordways lifts right and left from this as well as from the headways courses. It has been objected to this course that it requires a large consumption of timber, the time occupied in removing each lift being considerable; but if experience may be taken as a guide the very general adoption of the system seems to prove its advantage in practice.

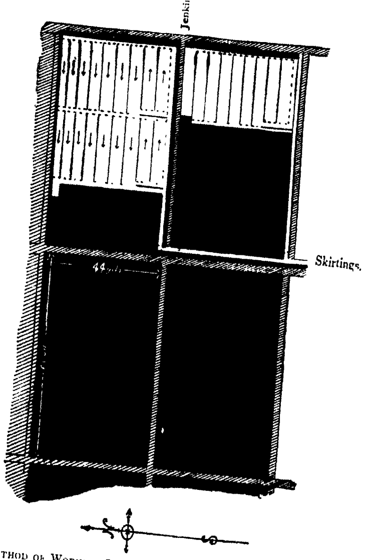


FIG. 97.—METHOD OF WORKING LARGE PILLARS IN THE MAIN COAL SEAM AT EPPLETON COLLIERY. Scale, ½ inch = 1 chain.

The guiding principles to be observed in pillar working are:—

(1.) That the pillars should be of such a size as to prevent any general movement of the strata, whether of the nature of creep or of thrust, either during the whole working, or at the face during the working of the pillars.

(2.) As has been already pointed out (page 171) of advance should be maintained in working the broken, its direction being governed by the course of the coal facings and of the lines of fracture in the top stone. In many cases a line forming an angle of 45°, or thereabouts, with the headways courses is found to answer best. When a few pillars are allowed to fall behind, so as to become nearly surrounded with goaf, the coal becomes crushed, and it may be found impossible to work them. Much good coal has been lost in this way.

(3.) As soon as commenced, the more quickly a pillar can be worked off, the better.

(4.) Narrow work should be avoided as much as possible.

(5.) The system of working should allow, if possible, of most of the timber being drawn, so that it can be used again.

The following extract, from a report by the late Messrs Nicholas Wood and George Hunter, dated 8th July 1840, relative to pillar working at Thornley colliery, in South-east Durham, may be interesting:—They were asked what they considered "the best method of working pillars in the Five-quarter seam with reference to (*a*) the expense, (*b*) the production of the greatest quantity of round coals, and (*c*) the security of the mine both with regard to water and inflammable gas." The Five-quarter seam lies at a depth of 168 yards, and above it, and next the surface, are 64 yards of magnesian limestone and sand of the Permian formation, containing large feeders of water. Their reply was: "We consider the best method of working the existing pillars with reference to the expense, and also to the production of the greatest quantity of round coals, to be to take the narrow bords [size of pillars not given—probably narrow] as mothergates (rolleyways), and to drive headways 2 yards wide across the walls at intervals of every three pillars apart, thus leaving a pillar-and-a-half of coal on each side to be taken to each headways. Then to drive a jenkin 2 yards wide, wherever practicable, on the one side of the wall or pillar, and where not so, up the middle of the wall, working the remaining part of the pillar back towards the headways in the usual manner, or in that manner which, by experience, shall be found most advantageous. This plan of working the pillars will, we apprehend, have the effect of bringing down the sand-feeders of water—at least we are of opinion that such an event must be calculated upon and provided for; but as we consider that the best mode of working the whole mine involved this effect, it did not appear to us necessary to provide against it in determining the best method of working existing pillars. With respect to the security of the mine as regards inflammable gas, the mode of working which we have recommended will afford adequate means of ventilation, so far as practicable in pillar working; but the practicability or propriety of working the coal with candles or lamps can only be determined by experience."

Another question they were asked was: "Do you consider the present mode of working the Five-quarter seam the best and most economical method with reference to the future as well as the present cost; or what alterations and modifications do you recommend to be adopted?" They replied: "We do not consider the present mode of working the Five-quarter seam the best or most economical method, either with reference to the present or future cost. We think a simultaneous working of the whole coal and pillars the best and most economical mode, considering the nature of the roof and other circumstances regarding the seam; the working of the pillars to follow the working of the whole coal as nearly as possible, so that there may never be more than two headways in operation at once."

The system of following up the whole with the broken has much to recommend it. When the pillars can be removed before the walls have fallen, the expense of opening out afresh, ridding, setting timber, and laying way is saved. The workings, too, are concentrated, and the cost of putting and driving thereby reduced. There is less length of road to be examined and kept good, and less distance for the air to travel. On the other hand, in a seam which makes gas, the quantity of gas to be dealt with at one time will be increased by working the pillars immediately behind the whole, and if the top stone does not fall readily there will be the danger of having a large gasometer, close to the whole workings. Working away pillars may bring down a feeder of water, which may drown the whole workings if they are close at hand. Great pressure may also be thrown on the pillars which must be left to support the main roads, and these may be affected. When, however, the top stone falls readily, so as to speedily fill up the goaf, the best plan, certainly, appears to be to follow up the whole with the broken. Care should be taken that the goaf thus formed does not prevent the readiest access to districts to be worked in the future. The operations of some collieries are seriously hampered by the inconsiderate way in which goaf has been formed in the past.

It is usual in bord and pillar workings to make the bord longer than the wall, the walls being originally communications between the bords simply for the purpose of ventilation (see Chapter I.). The advantage of this is, however, doubtful. At some collieries the walls are made longer than the bords. For instance, at a colliery in West Durham the walls are driven 30 yards in length and the bords 20 yards, and the pillars are worked in bordways lifts driven 10 yards up at each side of every headways course, as shown in Fig. 98. It is claimed that the coal is thus worked more cheaply, because a larger proportion of it is got at broken price, and also the length of lifts in removing the pillars is only 10 yards; and the coal is, therefore, better got, and less timber is used than would be the case if the bords, and therefore the lifts, were longer. The following calculation makes this clear:—

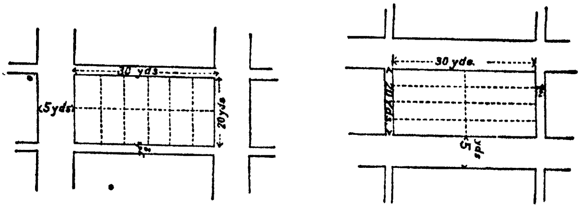


FIG. 98.

FIG. 99.

SKETCHES ILLUSTRATING THE RESULTS OF ALTERING THE RELATIVE LENGTHS OF BORDS AND WALLS.

FIG. 98.

Coal got in first or whole working.

Bord 22 yards × 5 yards = 110 square yards.
Wall 30 " × 2 " = 60 "
170 "

78 per cent. of the seam is put into pillars by this method.

FIG. 99.

Coal got in first working.

Bord 32 yards × 5 yards = 160 square yards.
Wall 20 " × 2 " = 40 "
200 "

75 per cent. of the seam is put into pillars.

Three per cent. more of the seam is got in pillars by the first of these two methods; but, on the other hand, there is in that method more yard price to pay, namely, 10 yards at (say) 1s. 4d. = 13s. 4d.

200 square yards – 170 square yards = 30 square yards; and estimating the seam to be 3 feet thick, and to weigh 19 cwt. per cubic yard, this gives 28 tons more coal got per pillar in the broken working by the first method than by the second: 28 tons at say 2d. per ton (assuming broken price to be 2d. per ton less than whole) = 4s. 8d. There does not seem to be any saving in cost of working, assuming that the top stone is such as to allow the lifts to be driven up a distance of 15 yards. The shorter lift is certainly an advantage in favour of the first method.

A previous instance similar to this has been given on page 186 (Fig. 94), where, in working the Hutton seam at Hetton colliery, the places driven north and south (or walls) were made 66 yards long by 5 yards wide, and the places driven east and west (or bords) 33 yards long by 3 yards wide. Here the alteration in the widths of the places driven will affect the calculation in favour of the change.

CHAPTER XII.

WORKING BY LONGWALL.

LONGWALL is said to have been first practised in this country in Shropshire some three centuries ago, and to have been suggested by the method of working metalliferous lodes.

Mr G. C. Greenwell, the well-known author of a treatise on Coal-Mining, first published so long ago as 1852, pointed out in a paper "On the Working of Thin Seams of Coal, &c.,"* which he read in the year 1856, that in some of the "more highly favoured coal districts of this county (Northumberland) seams of 2½ feet and more were considered unworkable to a profit, and were left untouched in consequence"; but he reminded his hearers that the day would come when "these seams will be of greater consequence than the thick ones": and it may be said, without fear of contradiction, that Mr Greenwell has lived to see that day. That these thin, hard seams are now being worked to advantage, is largely due to the adoption of the longwall system of working.

The longwall system proper is that practised in Derbyshire, Notts, Yorkshire, and the Midland coalfields generally, where, after pillars of coal have been left for the protection of the shafts, the whole of the seam is removed in every direction from the shafts, roads being kept through the goaf. Sometimes the roads are first driven in the coal to the boundary, and then the longwall face brought back towards the shaft. The drawback to this is that time and money are required for driving the narrow places, before any profitable output of coal can be secured. Under certain circumstances, however, such as a liability to gob (or goaf) fires, this longwall "retreating," as it is sometimes called, well repays the preliminary outlay.

---

* *Transactions of North of England Institute of Mining Engineers*, vol. iv., p. 193.

In ordinary longwall, the face may be carried forward in one long continuous line, sometimes a mile or more in length; or it may be "stepped," in widths of 10 to 40 yards or thereabouts, each width being 4 to 6 yards in advance of the adjacent one. The tub-way is sometimes laid along the face, and the tubs thus taken along the face to be filled with the fallen coal; or sometimes the coal is filled into the tub standing in the gateway. This depends mainly on the thickness of the seam. The distance between the roads or gateways varies considerably, being from 10 to 100 yards, the narrower intervals being necessary in thin seams, where there is not height for the tub in the face, and where the coal must therefore be brought along the face to the tub in the gateway.

In the Northern coalfield, besides true longwall, a modified system is practised—a combination of pillar working and longwall. Roads are driven in the coal, and subsequently maintained as gateways through the goaf, at intervals of 30 or 40 yards, and the coal between them is removed by "lifts" or "juds" driven about 6 to 12 yards wide to the right and left of each road, the lift being driven half the distance between the roads—that is, 15 or 20 yards, or otherwise, as the case may be. Sometimes these lifts are all driven in one direction the whole distance from one gateway to another.

In **Northumberland and Durham**, longwall working is chiefly practised in thin seams, where there is not height for the ordinary coal tub to be taken along the face. This necessitates the gateways being made at such intervals, usually 10 or 12 yards, as will enable the hewers to fill their coals into the tub standing in the gateway; or else special tubs have to be made of such a height as to enable them to be taken along the face, which is not often done; or a small tram has to be used to bring the coals along the face to the gateway, where they are "teemed" into the tub. This last alternative has been tried in one or two instances, but abandoned. The two latter alternatives admit of longer intervals—30 or 40 yards—between the gateways, and a consequent saving of two-thirds or three-fourths of the stone-work. The arrangement, however, most generally adopted is to make the gateways at intervals of 10 yards, allowing two hewers in each shift to each gateway, with crossgates at intervals of 30 or 40 yards, packwalls 5 to 7 feet thick being built at each side of every gateway. It entails a large amount of stone-cutting and pillaring, and the extra cost of this as compared with bord and pillar working will, as a rule, counterbalance the reduction in the hewing price; but under favourable circumstances it gives a larger proportion of round coal, and has the balance of advantages in its favour.

The arrangement of labour is the same as that customary at collieries in the district. The hewer kirves, gets, and fills the coals into the tub, which the putter takes to the "flat." The stone-cutting and pillaring are done at nights by the stonemen and shifters. There are two shifts of hewers, the fore-shift coming to work usually about 4 A.M., followed by the back-shift about 10 A.M. They are paid according to the number of tons of coal which they send to bank, irrespective generally of whether it is small or round, though at some of the Northumberland collieries they are only paid on the round. During each shift every hewer is working for himself, his interest being to fill as many tubs as he can. He does not share with his neighbours, but generally, though not always, he shares with his marrow (or partner), who follows him in the succeeding shift. This system is probably not the best adapted to longwall working, to get the full benefits of which it is sometimes important that the face should be kept straight, should be carried forward as regularly as possible, and that the kirving should be continuous along a good length of face, before the coal is allowed to fall.

Recognising this truth, some managers have adopted the division of labour which is common in Derbyshire and elsewhere—namely, that of holers, getters, and fillers—thus dividing the hewers' work into three classes of labour.* As an instance of this, we may take a Durham colliery working, at a depth of 184 yards, a seam of following section:—

---

* The following regulations were drawn up for the guidance of the men working in the Harvey seam of a Durham colliery:—

"REGULATIONS TO BE OBSERVED IN WORKING THE LONGWALL, HARVEY SEAM.

"*Note.*—Men employed in Longwall are subject to the General and Special Rules in force on this Colliery.

"*The Holers* to kirve under the seam 3 feet 6 inches, or such distance beyond that as may be agreed upon from time to time. To cast back all band, &c., got in 'kirving,' into the goaf, and to keep it out in front of the timber and packs. To put in their own 'stays' where required. After finishing holing or kirving the prescribed distance, all band, stone, dirt, small or refuse coal to be cleared away along the face so that the coal will fall upon the clean thill.

"*The Getters* will take down at night the coal made ready during the day.

"*The Fillers* to stand eight hours bank to bank; to take down all loose coal, shaken by shots or wedges, along the face. Any extra work required will be paid for at the usual rates current on the colliery."

	Ft.	In.		Ft.	In.
Coal	2	9		...	
Stone band ...	...			0	3¾
Coarse coal ...	...			0	5
	2	9	+	0	8¾=3 ft. 5¾ in.

Gateways are made at intervals of 40 yards, and the face is kept straight. In a length of face of 120 yards, there were employed 11 holers, 1 getter, and 4 fillers. The holers are divided into two shifts, coming to work at the same hours as the ordinary hewers do. They "hole" in the coarse coal and band, casting it all back into the goaf, and put sprags in under the 2 feet 9 inches of good coal. The result is that 75 per cent. of the seam is got as round. They are paid 8d. to 11d. per yard, according to the nature of the coal. The getter comes in with the back-shift, and stays to fire the shots after the other men have ridden. He is paid 1d. per yard length of face of coal got. The fillers come down at 6 A.M., when the pit commences to draw coals. They not only fill the coals, but also "put" them to the flat. They are paid by the score of tubs they fill, and an extra price of 3s. a score had to be paid for tramming along the face and filling into the tub at the top of the gateway. Owing to this extra cost, and also to the difficulty of bringing the large coal along the face, the big lumps having often to be broken, it was found after a trial that this method did not answer so well as where the gateways are made at intervals of 10 yards, and no way is required along the face; and this system was therefore adopted in preference, 2 feet of bottom stone being taken up in the gateways, and a stone pillar 4 to 5 feet wide built on either side; the cost of this work is about 6d. a ton on the coal got.

The same system of working and arrangement of labour was adopted at another Durham colliery in a seam 3 feet 2 inches in section, with a bad roof, consisting of a soft "following" stone several feet thick. A modified longwall had been tried—viz., making gateways 40 yards apart, and working the coal between in "lifts" 9 yards wide driven half the distance between the gateways right and left of them—but this did not answer where the top stone was very bad. A long straight face was therefore tried, with gateways at intervals of 40 yards, and a way laid along the face for a small tram, in which the coal was brought to the gateway, and there "teemed" into the tub, and the holing, getting, and filling were done by different sets of men. In this case the holers were arranged in parties of three, who shared together, the price paid

Being 8½d. a yard for holing 3 feet 2 inches under, the height in front not to exceed 16 inches. There were two sets of three to each 40 yards. The getters were paid by the shift, 4s., and there was one of them in each shift. The fillers were paid according to the number of tubs filled, as before.

Here, too, it was found that tramming along the face did not answer, and that it was better to make gateways at shorter intervals so as to avoid it. The division of labour, however, is highly spoken of, and certainly seems better adapted to effective and continuous kirving, and to getting as much round coal as possible, than where one man is kirving, getting, and filling in 5 or 6 yards of face independently of what his neighbours are doing, his only interest being to fill as many tubs as he can for himself during the five or six hours he is in the face. There are no doubt advantages in division of labour, such as (i.) increase of dexterity in every particular workman, and (ii.) saving of the time which is commonly lost in passing from one kind of work to another. On the other hand (as pointed out long ago by that eminent authority, Adam Smith), something may be said—mainly, perhaps, from a humanitarian point of view—as to the benefits of variety of occupation. The change from kirving to drilling or wedging, and then filling, must be a relief to the workman, and perhaps he is able to do more work this way than when confined to one class of labour.

The modified system of longwall already mentioned is practised at a good many collieries in Durham and Northumberland. At a colliery in Northumberland this method was practised in the Low Main seam, at a depth of 120 yards, the section of the seam being:—

		Ft.	In.	Ft.	In.
Coarse coal	...	...		0	5
Stone band	...	...		0	2
Good coal...	...	4	0	...	
		4	0 +	0	7=4 ft. 7 in.

It was always worked below the band, which made a good parting to timber against, but fell freely after the timber was drawn. Headways were turned out of a narrow bord at intervals of 30 yards. After they had been driven 10 yards, lifts 8 yards wide were turned away to the right and left, and driven 15 yards up, or half the distance between the headways. Two hewers at a time worked in each lift. At first the way was laid down the centre of the lift, the roof being supported by props and chocks at each side but after a time, to save timber, it was laid next the coal side, with a row of chocks on the other side. When the first lifts had been driven up a few yards, the headways or winning-place was widened out to 6 yards, and driven forward at this width, two hewers at a time being employed in it. Stone packs 7 feet wide were built at each side, leaving 6 feet space between them. With two lifts and the winning-place going, there were six hewers at work together in each gateway, and the tubs they filled were sufficient to occupy one putter in removing them to the flat. The arrangement is shown in Fig. 100.

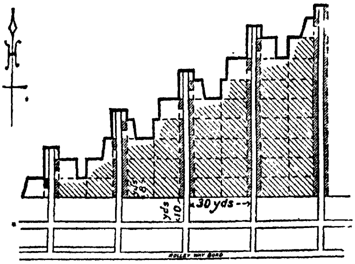


FIG. 100.—MODIFIED LONGWALL WORKING.

At another colliery a seam 2 feet 3 inches in section, at a depth of 218 yards, is worked in a similar way, the gateways in this case being 40 yards apart, and the lifts 9 yards wide. Right and left hand lifts are not allowed to be going opposite to each other at the same time, as this would throw much extra pressure on the timber and packwalls. The top stone is a strong post (sandstone), and about 2 feet of bottom stone are taken up to make 4 feet height on the rail. Chocks are used in timbering the lifts, the cost of which comes to about 3½d. a ton.

Sometimes the lifts are driven the whole distance from one gateway to another, where the top stone is very strong. This was done in a seam 3 feet 4 inches thick, at a depth of 300 yards, with a hard sandstone roof, the distance between the gateways being 40 yards. Chocks were used for timbering, and were nearly all got out after a lift had been driven. The lifts were 8 to 12 yards wide. To make height in the gateways, 2 feet to 2 feet 6 inches of top stone was taken down, and 1 foot to 1 foot 6 inches of bottom stone. This allowed a margin for squeezing. The packs were built 12 feet wide. The output per hewer per shift was more than doubled, as compared with bord and pillar working, but eventually this way of working was abandoned on account of the expense of shooting down the hard top stone. The bottom stone was found to be too soft for packing, and it was necessary to "get" the hard top stone, which never fell of itself.

The following mode of working a seam at a large colliery in the county of Durham was in vogue some years ago. The seam at the shaft was 347 yards from the surface, and had an inclination of 1 in 18, which, as the surface was fairly regular, and the district where the modified longwall working was being carried out was about a mile from the shaft and in the direction of the dip, would materially add to the thickness of the superincumbent strata at this point. The section of the seam averaged as follows:—

	Ft.	In.
Clean coal	3	0
Bottom coal	0	3
Splint	0	1 = 3 ft. 4 in.

The roof consisted of a panel of blue stone (shale) about 4 feet thick and of a somewhat broken nature, above which was a bed of strong white post (sandstone). The thill was seggar (or fireclay), about 2 feet in thickness. The gateways were 66 yards apart, and when these attained a length of 120 yards a cross gateway was put across the whole district. The coal was worked by bordways juds or lifts 6 yards wide, driven half-way across between the gateways, or a distance of 33 yards. The No. 1 gateway is farthest advanced, each succeeding gateway being one jud behind the other, so that a diagonal line of face is preserved, and, the coal being of a tender character, crushing is prevented. It was owing to the tenderness of the coal that the modified longwall was adopted in preference to the longwall system proper.

When it was desired to win out a jud, the gateway out of which it was to be turned was driven 6 yards farther in and 2 yards wide, the jud being turned away out of this: 10d. per yard over and above the score price was paid for this winning out. The coal was kirved the full width—6 yards—across the jud, and nicked up the fast side, and wedged down with steel wedges. In no case was blasting allowed, on account of the gassy nature of the seam. The bottom, which consisted of seggar, was taken up to make travelling height, by a special set of men termed "bottom cutters" (who did the work during the night), for a width of 3 feet, the greater portion of it being cast into the goaf, and only a small quantity sent to bank for brickmaking. The timbering in the juds was arranged as follows:—A row of chocks not less than 5 feet apar was placed along either side of the tramway, and wherever the stone was dangerous, props and planks were set across the tram road as well. Across the face were set three pair of gears, three deep, which of course were continually being advanced. A row of small props, supporting planks, were arranged along the "fast" side of the jud, about 1 foot 6 inches from the coal, in order to preserve an airway about the face, as illustrated in Fig. 101. The gateways were packed on either side; this pillaring being about 6 feet thick, and built with suitable stones taken out of the goaf. The gateways were 8 feet wide between packs.

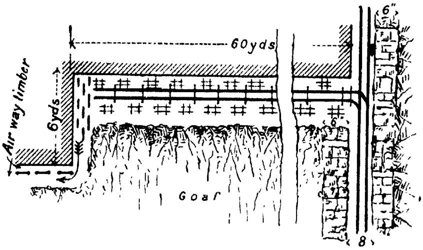


FIG. 101.—TIMBERING IN MODIFIED LONGWALL WORKING.

A detailed estimate of the relative cost of working this seam by the modified longwall thus described, and by the bord and pillar method as practised in another district having the same section of seam and the same general characteristics, is given in an Appendix (page 307).

The system is carried out on a large scale at another colliery in working a seam lying at a depth of 260 yards, and having this section:—

	Ft.	In.
Coal	1	7
Splint (picked out on the screens) ...	0	5
Coal	1	6
	3	6

The seam is very hard to hew—owing partly, perhaps, to another seam 20 yards below having been already worked—and it could not be successfully worked by bord and pillar.

At the same colliery, another seam, 328 yards deep, is worked similarly. Its section is:—

	Ft.	In.	Ft.	In.
Ramble or following stone ...	...		0	1½
Coal	2	6	...	
Fireclay band	...		1	0
Coal	1	4	...	
	3	10 +	1	1½=4 ft. 11½ in.

The band and ramble, which are thrown back, fill up the goaf, and the top stone—a "blue metal"—does not fall. Fig. 102 shows the plan of working. The gateways are made 40 yards apart, and the lifts, 8 yards wide, are carried the whole distance between the gateways, and are all driven in one direction—namely, towards the rise of the seam, which is westwards, or bordways. They are kept one behind the other, so as to make a stepped face. There are two hewers working at a time to each gateway. The way is laid down the centre of the lift. Chocks are used for timbering, and some stone packing is built on the "loose" side of the lift, next the goaf. Crossgates are made at intervals of 40 (or sometimes 60) yards, which allows some of the other gateways to be done away with, and the rails to be taken up. The air is taken round the face, as shown on the sketch. With bad top stones, this becomes a difficulty, and is an objection to the system.

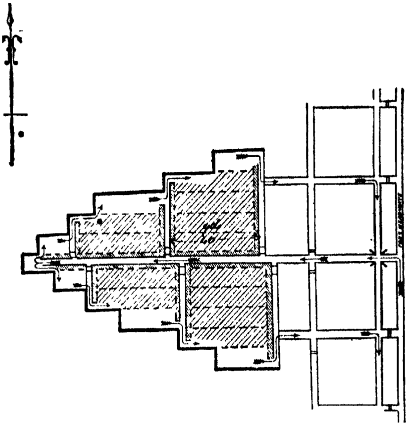


FIG. 102.—MODIFIED LONGWALL WORKING (ANOTHER INSTANCE).

This method of working, however, gives many of the advantages of longwall, in the concentration of the workmen, the avoidance of narrow work, and the using of the top pressure to assist the getting of the coal; and it costs less for stone-cutting and pillaring than where roads have to be kept through the goaf every 10 yards.

Removal of Pillars by Longwall.—Sometimes pillars are worked out on the longwall principle, and an instance has been already given at page 183. This was also done in a seam where the top stone was very hard and strong, and the thill soft, and the bords had crept close. The seam was at a depth of 170 yards, and in section was as follows:—

	Ft.	In.	Ft.	In.	Ft.	In.
Ramble or following stone	...		...		0	9
Coal	1	2	...		...	
Seggar band	...		0	8	...	
Coal	2	7	...		...	
Coarse coal	0	4	...		...	
Splint	0	5	...		...	
	4	6 +	0	8 =	5	2

The pillars, which were 30 yards bord by 20 yards wall, were worked off in one face of 20 yards, carried the whole distance of 30 yards. Four hewers at one time were hewing in the face. Two ways were kept by chocks (which were always got out afterwards), and the remaining space was nearly filled with the seggar band and ramble thrown back. The men hewed as much as 6 tons a shift, and 1½d. a ton less was paid for hewing than in cases where, the roof not being good enough, the pillars had to be worked in lifts.

In Yorkshire and the southern mining districts, thick as well as thin seams are worked by longwall, and there are various arrangements of labour. At a colliery near Leeds, the Haigh Moor seam lies at a depth of 112 yards, and its section is:—

	Ft.	In.	Ft.	In.
Good coal	3	0	...	
Soft clay band	...		0	3
Coal	1	9	...	
	4	9 +	0	3 = 5 ft.

It is worked as follows:—The face is kept straight, and is carried forward in a cross-cut ("half-end and bord") direction. Gateways are made at intervals of 33 yards, packwalls 7 or 8 feet thick being built at each side, and also at intervals of 6 feet throughout the gob. The coal face between two gateways is called a "bank," and each bank is divided between two sets of men—three to each set—

so that each set of three has 16½ yards of face to work. They kirve and get the coal; fill it into tubs (the small over riddles of ⅞-inch mesh, what goes through being left below); set the timber; and stow the loose stone in the gob behind. They are paid a fixed price per ton of coal they fill, each set of three sharing together. The kirving (or "bearing" as it is locally termed) is made in the band and inferior bottom coal, and is always made for the whole width of 16½ yards, sprags being put in 6 feet apart, before the coal is allowed to fall. It has then to be broken up. The men go down at 6 A.M., and their shift is eight hours. In this district there is only one shift of hewers.

At this colliery, the system of forewinning and working backwards is sometimes followed, narrow endings being first driven to the extremity of a district, and the coal brought back in one line. There seems to be no decided preference for one plan over the other, the extra cost of driving the endings, and the larger proportion of small coal thus made, and the delay in getting a good quantity of coal, just about counterbalancing in this case the cost of making and keeping roads through the goaf.

At another colliery in the same district, the Beeston Bed—which is 4 feet thick, and lies 143 yards in depth—was worked on what is sometimes called the Derbyshire method. A pillar of coal 100 yards square was left round the two shafts; and beyond this, the whole of the coal was being removed in every direction, all the roads being through goaf. Two feet of top stone—which was hard "bind" or argillaceous shale—was first taken down in the gateways, but usually 5 feet of stone had to be removed before the road could be considered permanent; or, in other words, every permanent road had to be cut afresh out of the stone. At each side of every gateway, a packwall 9 feet thick was built, then 9 feet of gob, then a 6-feet pack, and so on. The leading places were going on face or bordways, and out of them, at every 30 yards, gateways were turned endways. Cross-gateways were made at intervals of about 300 yards, and at a course of 7 inches per yard from "face" or bordways, to cut off the gateways. Four men worked at each bank of 30 yards, and they kirved as well as got the coal, filled it into loose-ended tubs, the small coal over 1-inch riddles, built packwalls, and set timber, for 1s. 10d. a ton. When filling, a way was laid along the face of the bank, 2-feet gauge, and flatsheets were put down at the top of the gateway to enable the tub to be turned round readily.

The famous Barnsley Bed of South Yorkshire has been largely worked by longwall. In one instance, it was 7 feet thick, lying at a depth of 279 yards. The banks were 30 yards, four colliers in each, and the face was "stepped," on account of fissures in the top stone.

At another Yorkshire colliery, the same seam is worked at a depth of 450 yards, and is of the following section:—

	Ft.	In.	Ft.	In.	
Day bed	1	3	1	9	got in gob, but left on packs.
Dirt	0	6			
Softs	1	5	8	5	
Clay seam	1	4			
Hards	3	2			
Softs	0	7			
Slotting coal ...	1	11			
	10	2			

It lies at a gradient of about 1 in 10. The face is carried in a cross-cut direction, or "half-end and bord." The banks (or stalls) are 40 yards wide. In each of them five colliers are employed at a contract price of 1s. 4½d. per ton, for getting and filling the coal into tubs, timbering, building packs, and laying way. They engage two fillers per shift. The output of coal from each bank averages 20 tons a shift of eight hours. The gateways require no "ripping" or "stone-cutting" as a rule, but the stone falls in them, and is cleaned up by the night-men, and used for building the packs. The day bed forms the roof in the face; it is left above the packs, but is got in the gob between the packs. Three rows of props are kept in the face.

In the **Cannock Chase** district of **South Staffordshire**, the two principal seams—known as the Shallow and the Deep seams, 7 feet and 6 feet thick respectively—are got in very good condition by longwall working. The usual practice is to keep a straight face, and carry it in a cross-cut direction about "three-quarter end." Gateways are made 30 or 40 yards apart. The distance of coal face between two gateways is called a "stall," and is let to one or two stall-men or contractors, who are the most experienced of the colliers. They contract to get the coal (in the prescribed way as to holing, &c.), deliver it into tubs at the top of the gateway, set the timber, build the stone packing, and lay the rails, finding their own powder and candles—the owners finding timber and rails—for a price varying from 1s. 4d. to 1s. 6d. a ton on the coal got. They engage the holers and fillers and pay them their wages, and make about 5s. a shift for themselves. There is only one shift of coal-getters in the twenty-four hours. They go down at 7.30 A.M. and ride at 4 P.M., the hours during which the pit draws coals. From 11.30 to 12, every one stops work for breakfast. The rock-rippers and night-men go down about 10 P.M.: 20 tons per eight hours is considered a good output for a 40-yard stall, and in a stall of this width there will usually be six men employed. The holers are very skilful at their work, and one sees holing 6 feet in, and not more than 2 feet high in front. Where there is some soft stone just below the seam with a good parting from it, the holing is done in that, and the whole of the coal is got in good condition; but in some cases it is made in a soft carbonaceous shale or "ramble" above the seam. This is termed "bannocking"; but more powder being required, and more levering, to make the coal fall, it is only adopted where there is no suitable material for holing at the bottom of the seam. With the holing underneath, a few shots of powder fired, after the sprags have been withdrawn, bring down a very large fall of coal. The large lumps are filled into the tubs by hand, and the small is filled over riddles, what goes through being thrown back into the gob. The stone-work is done by separate contract. To get stone for the packwalls, small spaces called "wastes" are left in the gob, not far from the coal face, unsupported by timber or packing, where the stone falls freely.

At Cannock Wood colliery, the Deep seam lies at a depth of 200 yards, and its average section is 6 feet 10 inches. In one district of the colliery it was worked under a very bad top stone, a jointy shale with no good parting for about 10 feet up. Bord and pillar was tried, but it was said to be impossible to keep the top-stone up in the bords. It was, however, successfully worked by longwall, with a straight face, the stone packing being kept well up to the face, within 4 or 5 feet of it, and the gob made quite solid.

Thick Seam worked by Longwall.—It was mentioned on page 139 that thick seams could often be more profitably worked by the longwall method than by bord and pillar, and of this the following instance, taken from a Northumberland colliery, may be given.

The seam worked—the Main Coal—is of the following section:—

Top stone—thick panel of post.

	Ft.	In.	
Top coal	3	4½	
Band (seggar)	0	3	variable.
Bottom coal	2	8½	coarse.
	6	4	

Fig. 103, Plate XXVI., is a reproduction of a photograph taken in this longwall face, showing two hewers at work, and the overman leaning against a coal tub. The roof is a strong "framey" post (sandstone), and the thill is a bastard seggar or fireclay. The distance between the gateways is from 20 to 25 yards, the tramway being laid along the face, and moved forward as the face advances. Although the seam is sufficiently thick to afford good travelling height, yet about 3 feet of the roof is shot down in the gateways every night, for the packing in the goaf, and this proves of further use later on when the "squeeze" commences, which considerably reduces the travelling height in the gateways and cross-headings. The packing or pillaring is carried out in the following manner. The stone shot down after the back-shift hewers have left the pit is packed along the sides of the gateways to form a pillar 6 feet thick on either side, leaving the gateway 9 feet wide; a chock is also built 6 feet square half-way between the gateways to act as a central support; behind this stone chock the roof is allowed to subside, no timber (or as little as possible) being left in the goaf. Along the face, and on either side of the stone chock, props are placed as necessitated by the state of the roof—usually in rows three deep—which are advanced daily. The distance between the stone chocks is about 6 feet. It will be seen from Fig. 104 that the face is what is termed "hipped" or stepped—that is to say, an even or horizontal line of face is not preserved, but the first gateway is a yard or two in advance of the second, and so on—the amount of advancement being usually 2 yards—the reason for this being, that if an even line of face were kept, the line of roof fracture would be parallel to the face, and would in all probability extend right across the district, and it would be nearly impossible, with the limited packing, to support the roof.

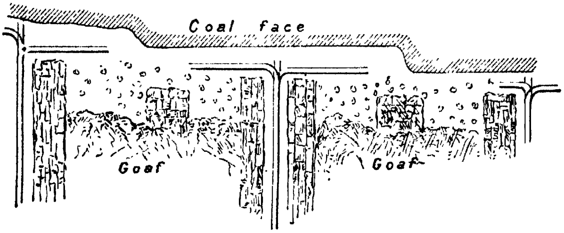


FIG. 104.—STONE PILLARING AND TIMBERING AT LONGWALL FACE.

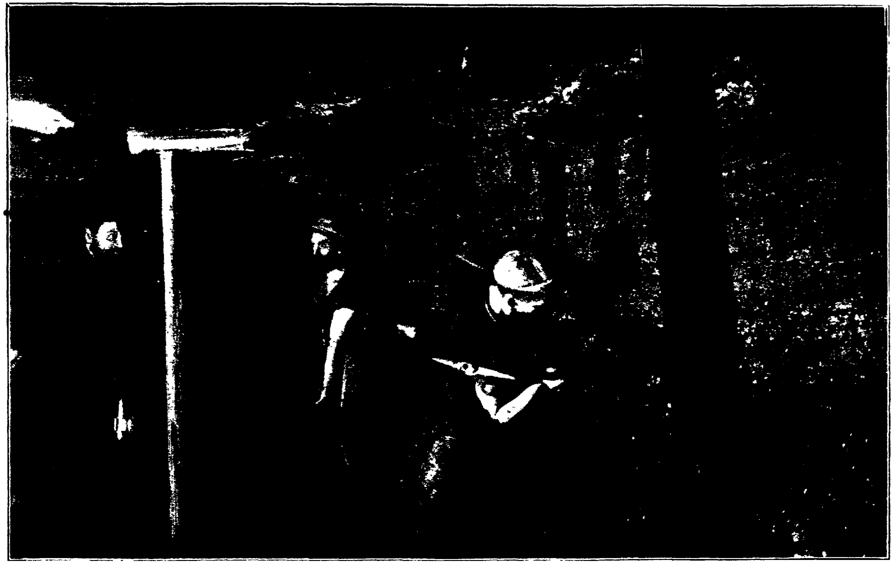


Fig 103.—Hewers working at a Longwall Face in a Thick Seam.

As it is, the breakage of timber is considerable, and the utmost promptitude has to be exercised in drawing it out and building the chocks.

The hewers kirve out the band in the winnings and shoot up the bottom coal; they then shoot down the top coal. At the longwall face, however, the pressure of the superincumbent strata upon the coal is sufficient usually to squeeze out the band, and the coal will hardly stand for kirving. It is desirable, therefore, that the face should be moved forward as fast as possible. The main advantage accruing from this mode of working is the greatly increased output per man, the average being 4.37 tons per shift.

Detailed description of the longwall system of working as practised in a **North of England colliery.***

The seam in question is a perfectly clean seam, free from stone bands and iron pyrites, and is worked for coal to be used for steam and house purposes, principally the former. Its average thicknes is about 2 feet 7 inches, but it varies from 2 feet 1 inch to 3 fee 6 inches, and attains a greater section in "swellies." Th floor is usually seggar (or fireclay), varying from 1 to 3 feet i thickness. The roof consists of sandstone (post), or shale (blu metal), with post girdles, or thick shale (blue metal). The synclina axis of the Northumberland coalfield runs through the royalties i a north-easterly direction, the full rise being S.E. on its easter side; whilst the measures in the western portion of the estat rise in a direction varying from S.W. to N.W. The average rat of inclination is about two inches per yard where the ground i not affected by faults, and the cleavage runs generally a little we of north.

The coal is worked outwards from the shaft to the boundar all being taken out at the first working, except that which is left i pillars to protect the main rolleyways, and occasionally beneat buildings. By the terms of the lease, the coal has to be left unde some buildings, but it has, in certain cases thus provided for, bee removed, and in one case beneath a stream also, without an injurious effects, the thickness of cover being about 50 fathom On the plan shown in Fig. 105, Plate XXVII., will be seen tw buildings, beneath one of which a pillar has been left, whilst under the other the coal has been worked.*

---

* For some of the particulars in this description the authors are indebted Mr George Hurst of Newcastle-on-Tyne, who has allowed them to make su use as they deemed advisable of his admirable paper on the subject (see *Journ Brit. Soc. Mining Students*, vol. ix., p. 168).

The coal is won in the first place by driving a pair of (or sometimes three) winning headways or narrow bords, as the conditions of the district to be worked demand. These winnings usually consist of a fore and back place driven in the solid, for which the men are paid yard work in addition to tonnage price. The fore-place, being used as a rolleyway, is driven 12 feet wide and 6 feet high, and the back-place 9 feet wide. Usually, however, the back-place is made to "stow itself"—that is, it is driven of sufficient width to hold the stone which has to be shot down for pony height. This width varies from 12 to 18 feet, according to the height of the seam. Stentons, 14 to 15 yards long, are holed every 44 yards. Barriers of solid coal, 35 yards wide, are left on each side of the winning-places, the object being to protect the main roads, to lessen the cost of timbering, and to permit of the air being borne up for any distance without loss. Where no barriers of coal are left, it is impossible to prevent scale through the stone pillaring until this has been consolidated by the pressure, and all motion has ceased, which does not occur for a considerable period. Within 200 or 300 yards of the boundary no barriers or stenton coal are left, the fore and back places being then formed by driving one wide place, and building a stone pillar in the middle, with a tramway along each side.

The winning-places having reached a point sufficiently far from the shaft, the longwall is commenced. Suppose, then, that we have a pair of winning headways. A holing, driven 12 to 18 feet wide to "stow itself," is made through the barrier, and what is termed a "barrier place" is turned away, 5 to 10 yards wide, parallel to the headways (see Fig. 106). A stone pillar, 4 or 5 yards wide, is built against the barrier side in this road, the object of which is to prevent the roof breaking and coming down along the edge of the barrier when the coal has been removed at the other side by the longwall. As the barrier place proceeds, at every 11 yards a gateway, allotted to two men (one per shift), or to four men (two per shift) if pit room is scarce, is turned away bordways, or at right angles to the headways. By this arrangement each set of hewers has 11 yards of the face of the coal. The holings through the barriers are driven at intervals of 70 yards. Sometimes no barrier place is driven, but each set of men win out their own gateway in turn by working in a headways direction 11 yards, and then turning bordways. The former method is, however, considered the best. The seam being thin, 2 or 3 feet of the stone above the coal have to be shot down to make height for the putters and ponies. The stone is not taken down right across the place, but only a width of 3 or 4 yards to each 11 yards of the face, and a neat and substantial pillar, about 6 feet wide, is built on each side of the tramway, thus forming the gateway along which the coals are brought by the putters to the main road. The remainder of the stone shot down is stowed in the space or goaf between the gateways. One shot is generally sufficient to bring down all the 4 yards in each gateway.

---

* It was found that, unless the coal left beneath buildings for their support was extensive, the effects of the workings in the vicinity of the pillar was considerable, and more marked than if the coal were evenly and entirely extracted. This, it was presumed, was due to the block of coal acting as a fulcrum to the leverage of the superincumbent strata. From extensive experience in this particular district, when calculating the area of coal to be left under buildings, it was found expedient to allow of a "draw" of one-fourth of the depth of the seam from the surface—not that the horizontal "draw" was quite so extensive as this, but that there might be a margin of safety.

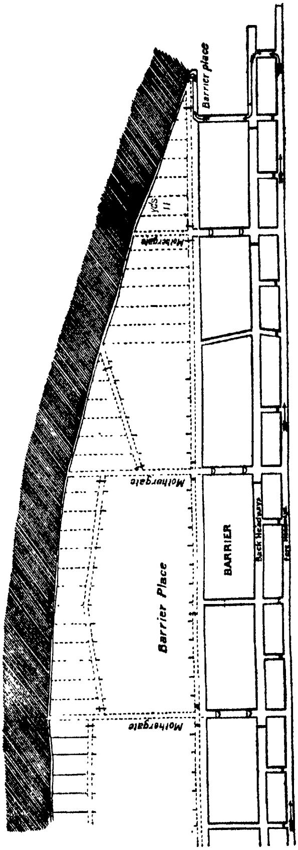


FIG. 106.—PLAN SHOWING WINNING HEADWAYS. Scale, 4 chains to 1 inch.
REFERENCES.—Brick Stoppings, ‖ ; Canvas Doors, | ; Wooden Doors, D D.

The most effectual mode of pillaring which is in operation at the colliery under consideration—that which has been found to entail least "backbye" work—is illustrated in plan in Fig. 107, and in section across the gateway in Fig. 108. Having shot down the canch it is disposed of as follows:—The pillar *b d* is built and keyed into the "face" pillar (*a b*) of the previous night. Then a new face pillar, *c d*, is drawn across the face 4 to 6 feet from the last face pillar (sometimes called a "cross" pillar), the smaller and surplus stones are filled into the middle, and the side pillar, *a c*, is then built and keyed into the "face" or "cross" pillars, *a b*, and *c d*. The pillars—which are, of course, built of the largest and most suitable stones—are made 6 feet wide. The pillaring is usually kept 4 feet back from the face. If, when the hewer commences his work in the morning, he finds that the roof is only moderately strong, it will be necessary to have a prop or two and headtrees between the coal face and the pillaring, especially at the point A. These are drawn out as the pillaring and the face advance, with the exception of those at the side pillaring, which keep up the side stone; but as the pressure of the superincumbent strata—or "squeeze," as it is termed—comes on, these side props are pressed out. Gears are occasionally necessary across the gateways when the top stone is bad.

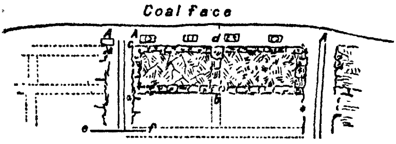


FIG. 107.—PLAN OF PILLARING ON LONGWALL FACE.

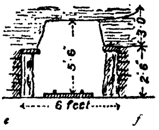


FIG. 108.—CROSS-SECTION OF GATEWAY.

Usually thirteen gateways constitute a flat, the central one being called a "mothergate," as all the coals from the other gateways are brought on to it by means of cross-headings, and conveyed along it to the main rolleyway. A cross-heading, or cross-gateway, is a road made in the goaf, running across the gateways. The mothergate, and cross-headings, and gateways are illustrated in Fig. 109. A cross-heading being formed, the flat can be shifted inbye, and thus the "putting" distance will be reduced, and also the quantity of rails required.

There are three modes of making, or putting over," cross-headings at this colliery. (i.) At one part of the colliery the stone immediately above the seam is a "panel" of very soft shale (*blue*), of varying thickness, and mostly very wet, which renders it more difficult to keep up than it otherwise might be. This stone, therefore, falls away from the "post" panel above it, and makes it very difficult to keep the sides of the gateways in a proper state. Owing to the existence of these conditions of roof, the method adopted of putting over the cross-headings is as follows:—No side pillars are built *across* the gateways when the distance is reached at which the cross-heading will cut them off, the idea being to let the blue stone

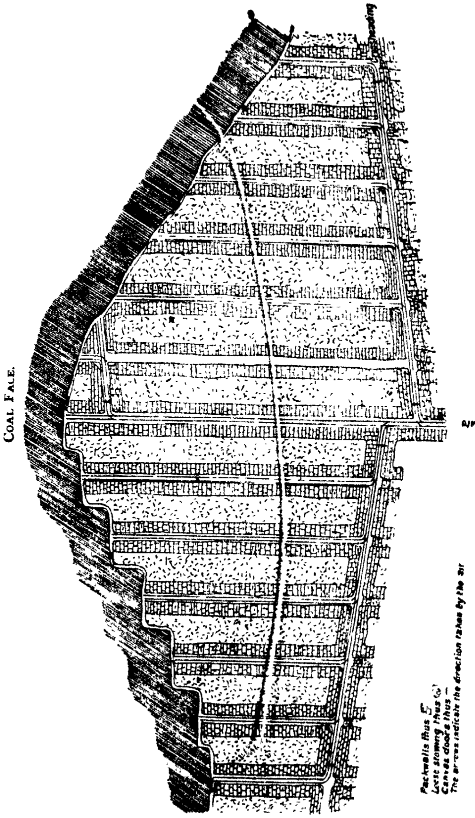


Fig. 109.—Drawing of Flat showing the Mothergate and Cross-Headings. Scale, 80 feet to 1 inch.

fall thoroughly, and the roof generally to settle, and then to rid through the closely fallen goaf. The worst of this mode is the high cost of ridding through the goaf, and the amount of "backbye" work which is entailed. (ii.) Another method is adopted where the stone is not so bad. When the gateways attain the distance at which the cross-heading will (when made) cut them off, side pillars are built across the gateway, so that when the cross-heading comes to be made there is an open road through the goaf, and it is merely requisite to shoot down the top stone between the gateways for height. (iii.) The best possible way, when practicable, of getting over cross-headings is to drive them in the coal as headways gateways, commencing from the mothergate (Fig. 110), which is driven in fast for a few yards for the purpose—4 yards or thereabouts.

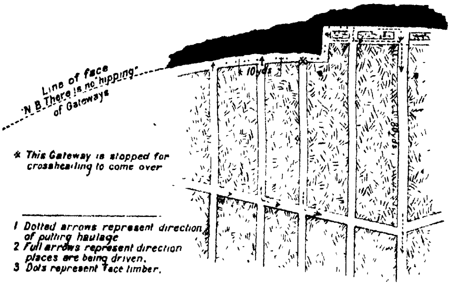

Line of face
N.B. There is no ripping of Gateways
10 yds
80 yds
* This Gateway is stopped for crossheading to come over
1 Dotted arrows represent direction of putting haulage
2 Full arrows represent direction places are being driven.
3 Dots represent face timber.

Fig. 110.—Mode of forming Cross-Headings.

When a gateway is nearly up for the cross-heading, it is stopped about 10 yards short of its full distance (80 yards), this remaining 10 yards of coal being got by the cross-heading cutting it off.

Some of the advantages accruing to the last-mentioned method are:—(1) The saving in shooting of top canch; the stone being easier to shoot than in the two previously mentioned methods, owing to its not being "open," because in the former cases where subsidence has occasioned numerous cracks and crevices, a considerable part of the blasting force is uselessly expended in these interstices. (2) The saving in the *extent* of top to be shot down. In a district comprising, say, 17 gateways, experience shows that at least 5 gateways are in such a position that they can be stopped before attaining their full distance, the remaining 10 yards in each being got by the cross-heading, and as the canch is in no case shot flush up to the coal, there are, say, 7 yards of the canch less to shoot in every 80 yards of gateway, or 170 yards less of canch for every 80 yards the district advances.

Such of the old gateways behind the cross-headings as are not required for airways are stowed up. In this way we get cross-headings on each side of the mothergate, at intervals of from 60 to 100 yards. It will be seen from the illustration given in Fig. 109 that the cross-headings are not made at right angles to the mothergate, and that they are "off and on," as the saying is—that is, the right and left hand ones do not meet at a point on the mothergate. There are several reasons for their not being at right angles to the mothergates, of which the principal reason is that, the coal being worked to the rise, the tractive force in putting inbye and outbye is equalised. Another reason is, that the gateways are cut off one by one, and consequently the cross-heading is formed gradually, and there is not too large an amount of stone to shoot down at once. Again, by making the cross-headings "off and on," the use of double-turns in the tram-plates is avoided, and there is not so much liability of collisions between putters coming in opposite directions on to the mothergate.

In the gateways, from 2 to 3 feet of top stone are taken down, and in the main rolleyways and mothergates from 3 to 4 feet, according to the height of the seam and the partings in the stone. All the stone-work (shooting, loading, conveyance of stones by tub and pony, pillaring, &c.) is done by night-shift men, the hewers merely getting the coal and filling it into the tubs. A canch of 5 or 6 feet in length is left in the face of each gateway, and is supported by short props set by the deputies, the long timber in the gateways being put in by timbermen in the night-shift. A space of 3 or 4 feet is left between the face and the stone pillaring, which gives the men room to work in, and allows the air to pass directly along the face.

The roof does not break along the line of face, but droops gradually on to the stone pillaring, squeezing or compressing it finally into two-thirds of its original height. For this reason stone has usually to be taken down in the mothergate rolleyways two or three times; but when this degree of compression has been reached, no more motion takes place, and, as a rule, they remain permanently good, and require no more timbering or attention of any kind.

The hewers usually kirve about 3 feet deep into the bottom of the seam, and if necessary shoot their jud down, but generally the pressure is sufficient to bring it down. Where there is a sandstone (post) roof, the top part of the seam is frequently softer than the bottom, and is then preferred for kirving, it being in this case necessary to put a shot into the bottom of the coal.

A somewhat different mode of working is that with headways mothergates, shown in Fig. 111. In this system, a place 22 yards wide is driven with a packwall in the middle 7 or 8 yards wide, thus forming two mothergates, one for the right-hand and the other for the left-hand gateways. Openings are left through the packwall over 60 or 70 yards, as the place proceeds, for the passage of the tubs. The men in these mothergates are paid yard work, and they may be considered as winning-places, the difference being that no barriers or stenton coal are left. The gateways out of these mothergates are formed every 11 yards, and are carried forward to a distance of 70 yards, when they will hole into the gateways of the adjoining flats. Only one of the mothergates is used as a rolleyway, the reason for having two being this: If there was only one, all the gateways right and left would have to be turned out of it, and consequently canvas doors would have to be

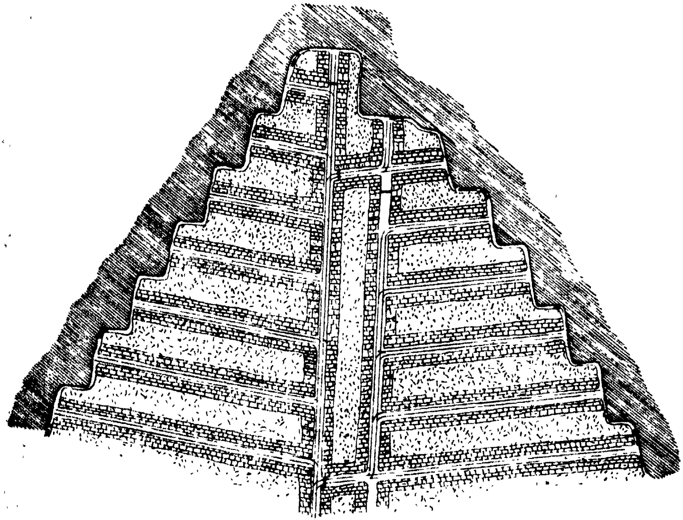


Fig. 111.—Drawing of a Flat with Headways Mothergates.
Scale, 80 feet to 1 inch. The shading shows the Coal Face.

put the gateways to bear the air up to the face, and there would be a serious loss from scale. These headways mothergates are not permanent roads, and in the course of time are cut off by a cross-cut from the main rolleyway, as shown at F in the illustration given in Fig. 105, Plate XXVII.

This system is a convenient one under certain conditions, but does not seem to have any economical advantages over the other. Originally three headways mothergates were formed, as will be seen from the plan in Fig. 105, Plate XXVII., as it was thought this number would be required to bear the air up properly, but two have been found quite sufficient for this purpose.

The mode of ventilation is very simple. The air from the downcast shaft is brought along the main rolleyways straight to the face, and after airing the men in the fore and back places, passes through the innermost barrier-holing on to the longwall face, along which it is carried, being borne up by wooden and canvas doors on the mothergates and cross-headings, as shown in Fig. 106, finally reaching the return, which will consist of old gateways and cross-headings left open through the goaf. The mothergates, gateways, and cross-headings are sufficiently ventilated by the scale through the canvas doors and pillaring. The air is split along the different main rolleyways, but there is not a separate split to each flat, the same split usually airing two or three.

The coal from the seam in question being used for steam and house purposes—principally the former—round coals are a desideratum, and in order to obtain as large a percentage of these as possible, the men are paid on the tonnage of round coals alone. The hewing price per ton is different at each pit, and varies inversely with the height of the seam. The following is the sliding scale at present in use :—

	Ft.	In.			s.	d.	
Above	3	0	in thickness	...	2	0	per ton.
From 2 feet 10 inches to	3	0	„	...	2	1	„
At	2	10	„	...	2	2	„
At	2	9	„	...	2	3½	„
At	2	8	„	...	2	5	„

And one penny per ton increase for every inch the seam decreases in height from 2 feet 8 inches.

The mode of working described above has been of late years much adopted in the northern coalfield. The cost of working, therefore, as averaged from four collieries working the same seam, about 2 feet 6 inches in thickness, may be of service :—

Pit Bill (Overman's), including :—

	s.	*d.*	
Hewing	1	9	per ton of coal drawn.
Yard work and consideration	0	2	„
Overmanship	0	2	„
Putting	0	1.75	„
Driving, rolleyway men, &c.	0	3.25	„
Total	2	6	
Stone work	0	9	„
Waste	0	0½	„
Timber	0	1½ to 2d.	„

The vital points to be considered in longwall working are:— (i.) The direction in which the face should be worked—whether "on face" (bordways), or "on end" (headways), or "half-end and bord" (cross-cut). This varies in different mines, and depends on the vertical "slips" or "backs" or "partings" in the seam itself, and in the roof stone. The advancing line of face should form an angle with the direction of these "slips." The support of the roof in the working face, and the getting of the coal in good condition, are largely dependent on this. (ii.) Whether the face should be kept in one continuous line, or stepped. This too greatly affects the maintenance of the roof, and the size of coal got. Experience has proved that an alteration in this respect may sometimes be most beneficial. (iii.) The rate of advance of the face. Sometimes it pays to let the coal stand for a little while on the timber sprags or cockers, after holing, so that the superincumbent pressure may act upon it; and on the other hand, sometimes, the faster the face can be moved forward, the better. (iv.) The building of the packwalls, and the stowing of the goaf. The packs should be built as strongly as possible, and carried close against the roof, and kept well up to the face. Where the goaf can be stowed solidly, it is the safest plan. Care should be taken to leave no timber in the goaf. Attention to these points will often make all the difference between a profitable working of a seam and the reverse.

In concluding this general view of the subject of working by longwall, it is perhaps hardly necessary to remark that the system is carried out, as the above instances show, in seams varying much in section, in depth, and in the nature of the roof and floor. With a straight face, and with kirving properly done, it is undoubtedly the system best adapted to making the highest percentage of round coal,* and to getting the largest possible proportion of the entire seam. Where gateways have to be made 10 or 12 yards apart, and where the stone is hard and requires the use of explosives, the working cost is high, and it becomes a question whether the improvement in the vend compensates for the extra cost of working, as compared with bord and pillar.

When the roof of a seam consists of 5 or 6 feet of soft rubble—more of the nature of soil than stone—which falls in the face, and is of no use for building packs, it is doubtful whether longwall can be pursued with advantage. It has been tried under such circumstances, and abandoned. There are other conditions—such as frequency of faults, and the necessity of leaving a large proportion of the coal to support the surface—which are unfavourable to longwall; and at coking collieries, round coal is not particularly wanted.

The arrangements of labour to which reference has been made are:—(i.) Where each hewer works independently in 5 or 6 yards of face; (ii.) where there are three classes—holers, getters, and fillers; (iii.) where three or four men share together, and work amongst them a certain length of face, doing all the work that is required in the face; (iv.) where one man is responsible for a certain length of face—say 20 yards—and finds and pays the other labour required. The authors are not prepared to advocate any one of these systems in particular, in preference to another, as best for general adoption.

---

* Upon this point, Mr Greenwell, from calculations made at Radstock (Somersetshire) in 1855, came to the conclusion that "a thin seam worked by board and pillar makes more small than a thick one"; "and," adds he, "it may be safely said that by the longwall mode as much round coal can be got out of a seam of coal 2 feet in thickness, as by the board and pillar method out of a seam 2 feet 9 inches, or possibly 3 feet." (See paper read before *North of England Institute of Mining Engineers*, vol. iv., p. 193.)

As to the relative liability to accidents, when both thin and thick seams are worked by longwall, Mr Greenwell maintains that "there is undoubtedly less liability to accident from fall of roof in a thin seam than in a thick one, when the quantity of coal worked is in proportion to the thickness of the two seams; otherwise, for the same quantity of coal, there is twice or thrice as much roof to work under in the former than in the latter instance, and consequently liability to accident must be greater."

The risk of accident in working by longwall is considerably less than by the bord and pillar system, for by the former method new and firm roof is constantly being exposed, the old roof to within a yard or two of the face being stowed up and pillared behind; whereas in bord and pillar the same roof is exposed (when working in the whole) for months, often for years. The great danger under the bord and pillar system of working is the drawing the timber out of old bords and walls, and when working off the pillars.

CHAPTER XIII.

STALL WORKING—DOUBLE AND SINGLE.

THIS system of working is native to South Wales, where it is still very generally adopted. Latterly, however, it has been giving place, to a large extent, to longwall in that district.

One of the first collieries in the North of England, if not the first, to try the double-stall method was Eppleton, belonging to the Hetton Coal Company. This was in 1885, when the system was tried in the Maudlin seam, owing to the unsatisfactory result of the bord and pillar method there, due to a very bad roof and thill. The seam was being worked entirely by bord and pillar before the double-stall method was tried, and in some parts of the pit, where the roof stands well and there is little or no lifting of the thill, bord and pillar is still being pursued. Owing to the loose, shaly character of the stone forming the roof of the seam in various districts of the pit, it was found very difficult to keep the roads in good condition: in fact, this could not be done on the old system without employing a considerable staff of shifters and wastemen, which, of course, contributed very materially to the cost of working. This being the case, it was determined to work the coal by that method which, while minimising the length of airway to be kept open, would at the same time not lessen, but rather tend to increase the produce for a given number of hewers, and be attended also with greater safety to the men generally.

The Maudlin seam, which lies at a depth of 308 yards from the surface at the shaft, and dips eastward at the average rate of about 1 in 14½, has the following section at a distance of 1,540 yards north-east of the shafts:—

		Ft.	In.	
2 ft. 7 in.	Top coal	0	11	Unmerchantable, therefore unworked.
	Stone	1	8	
Workable seam, 6 ft. 9½ in.	Good coal	1	7	
	Band of foul coal ...	0	3	This is not universal, being altogether absent in some places, and when present varies in thickness from 1 to 5 inches. It is cast back by the hewer, who is recompensed according to the thickness.
	Good coal	0	11½	
	Splint coal	0	3	
	Good coal	2	3	
	Stone band ...	0	6	Varies in thickness, in some places being absent altogether. Cast back by the hewer, who is paid according to the thickness.
	Bottom coal ...	1	0	Of variable thickness.
	Total height of seam	9	4½	

The stone between the seam proper and the top coal is generally "blue metal," but being of a soft shaly character, it forms an extremely bad roof. When working on the bord and pillar system, bore-holes were put up, about every 5 yards apart, through the stone band into the top coal to release the natural gas contained in these two beds, and so relieve the stone of some of the pressure. Although to some extent this acted beneficially, it was not found to be of much help in the long run. In parts of the seam the thill was very much subject to lifting—owing, it was thought, to the nearness of the Low Main seam, which in some places lies only a few feet below the Maudlin, the intervening strata being fireclay. This in itself is a strong reason for keeping open as few roads as possible.

The double-stall method is carried out as follows. A pair of narrow places, 8 yards apart, are turned away out of the headways course, and driven bordways way or "on face" for a distance of 10 yards. They are then connected by means of a narrow holing or "wall" driven parallel to the headways course, and so forming a "stook" or pillar of coal 8 yards by 10. The whole width of face—12 yards—is then carried forwards bordways way in the form of a "wide jud" or "stall." The distance which stalls are driven in the Maudlin seam at Eppleton averages about 44 yards. In the middle portion of the stalls the timber is drawn out as the face advances, and the roof allowed to fall. Two roads are kept, 2 yards wide, one on either side of the fallen stone, so that each road has a "fast" and "loose" side. The roof is supported by a row of chocks, set every 3 feet apart along the "loose" side of the road. Not less than three pairs of "gears" (props and planks) are kept across the face to protect the hewers. These are advanced every day, the stone falling behind them. The whole breadth of face is kirved across by the hewers and nicked up one side, and the coal brought down by driving steel wedges into the top of the seam. In no case whatever is powder allowed to be used, owing to the proximity of the goaf behind. The men kirve in the good coal on top of the stone band when present.

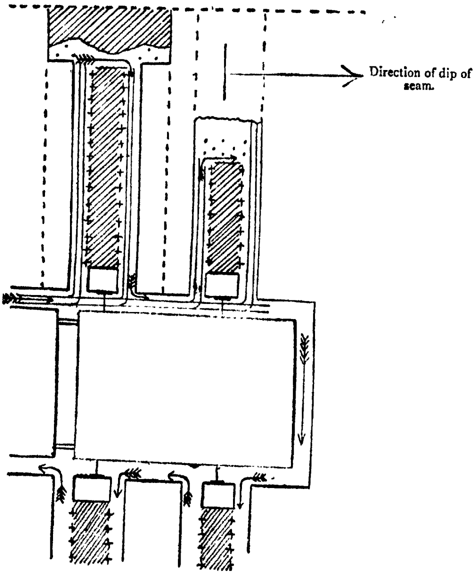


Fig. 112.—Plan showing Double-Stall Working.

After the stalls have attained the specified distance, the working back of the ribs which separate the juds or stalls from one another s commenced. That is to say, the ribs being 12 yards wide, a width of 6 yards is worked off each rib out of each stall road (see Fig. 112). The plan shows a stall in process of advancement, and n the adjacent stall the working back of the rib to the stall roads.

When the stall working was first introduced into this seam, it was the custom to work off the ribs from the inbye end of the stall towards the outbye or headways course end; but it was found, after a trial of some months, that owing to the very broken nature of the roof, there was a great saving of back timber by working off the ribs in the same direction as the stalls are driven; for by the first method the rib was worked off by a series of short juds, seldom being driven farther than 6 yards, then drawn out, and a fresh one set away in front of the drawn-out portion. By this means a place 6 yards wide plus the width of the stall, 2 yards = 8 yards, was timbered right across; and it will be readily understood how detrimental this great width of place was to economy in timber. By the second method, the timber in one-half of the road alongside the rib, about to be removed, was drawn completely out, and the roof allowed to fall, and a place being driven into the coal, half of the rib was worked off half its length (that is, length of rib, if the stall were 40 yards = 20 yards), the width of the jud being 6 instead of 8 yards thick, as in the former case. This will be better understood by comparing Figs. 112 and 113.

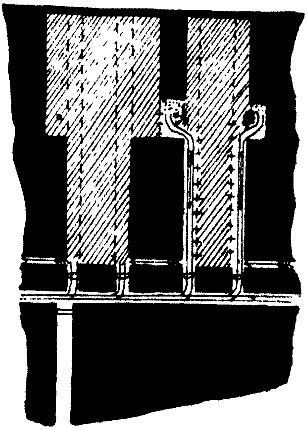


Fig. 113.—Removal of Ribs in Double-Stall Working.

There was nothing very complex about the ventilation. The air was forced up No. 1 stall road, down No. 2, up No. 3, and down No. 4, and so on. The safe ventilation of the workings, it will be observed, was dependent, in a great measure, on a large number of canvas doors, which were placed on the "going" or tramway (headways course). Constant traffic necessitated these canvas doors being constantly moved, and this, of course, tended to hinder the regular flow of air. In order to obviate this, holings were made through the ribs from stall to stall, the doors being placed in the stalls where the traffic was somewhat less than on the headways course. The air passed from stall to stall through the holing in the rib, thus shortening the distance it had to travel.

The produce of coal for a given area was greater by this system of working than by bord and pillar; the waste or loss in working, as nearly as could be calculated, being not more than 2½ per cent. No difficulty was experienced in getting the coal, which, when worked by bord and pillar, was found to be fairly hard in nearly all cases, generally necessitating the use of gunpowder, but this, as has already been stated, was in no case allowed under the double-stall system. It was thought that in bringing back the ribs some difficulty might be experienced in getting the coal owing to its having become "winded," but if anything, the produce per man from the ribs was greater than from the stalls. The following is a comparison of the average tons of coal hewn, and wage earned, per hewer per shift in the two systems as proved in the Maudlin seam, calculated over a single fortnightly pay:—

	Per Hewer per Shift.	
	Tons.	Wage.
Bord and pillar, "whole" workings ...	3.04	4s. 8.03d.
Do. do. "broken" do. ...	3.95	5s. 0.79d.
Double-stall workings	4.06	4s. 11.7d.

The various kinds of labour employed do not materially differ from those of bord and pillar. The *hewers* kirved, wedged down, and filled the coal, their wages being based on the following prices:—When driving the narrow places in the whole coal for the formation of the stook or pillar of coal, 13s. 10d. per score (21 tubs), each tub containing an average of 10 cwt. 2 qrs. (standard weight = 10 cwt.) weight of coals (= 1s. 3½d. per ton); when working the rib 12s. per score was paid (= 1s. 1d. per ton). The prices for bord and pillar in this seam were:—For whole working, 13s. 10d. per *score (= 1s. 3½d. per ton); and for broken, 13s. per *score (= 1s. 2d. per ton). Not less than four hewers per shift were employed in each stall, there being ample room for them all. The following were the yard prices paid to the hewers:—For driving narrow bords in whole coal, 2 yards wide, 10d. per yard; for holing across from bord to bord, 2 yards wide, 1s. per yard; for driving headways course, 2 yards wide, 1s. 6d. per yard. The yard prices paid in the bord and pillar system were the same as those stated on page 172; and the wages of the putters, drivers, and deputies were the same under both systems.

---

* These prices are for *standard* weights, any overweight being paid for at the same rate.

As regards the drawing of the timber, there was this difference, that, whereas in bord and pillar the deputies both set and drew it, in the double-stall workings a special set of men were appointed for drawing the chocks, and were paid 3s. 10d. per shift, being employed at the rate of about five shifts each fortnightly pay for six stalls.

In connection with the cost of working, it should be stated that the system was in a transition state when the calculation set out below was made, and it was expected that the charges would eventually be somewhat reduced, as experience should from time to time suggest improvements in the method of dealing with the difficulties that always accompany the introduction of any new method of working. In this table the costs for getting the coal by the double-stall system, calculated over six fortnightly pays, are given side by side with those of the ordinary bord and pillar mode of working:—

Labour.	Double-Stall.			Bord and Pillar "Whole" Working			Bord and Pillar "Broke Working.		
	Amount.	Tons.	Cost per Ton.	Amount.	Tons.	Cost per Ton.	Amount.	Tons.	Co per T
IG COALS—	£ s d		s. d.	£ s. d.		s. d	£ s. d.		s.
ing ...	181 2 4	3,310	1 1.13	161 16 4	2,706	1 2.35	289 15 8	4,868	1 2
work ...	8 2 6	...	0 0.59	27 7 5	...	0 2.05	3 13 9	...	0 0
lentals ...	3 1 4	...	0 0.22	5 16 11	...	0 0.51	7 2 7	...	0 0
tal hewing (percentages not included)	192 6 2	3,310	1 1.94	195 10 8	2,706	1 4.91	300 12 [illegible]	4,868	1 2
ty-work ...	34 4 1	...	0 2.43	31 19 0	...	0 2.83	51 6 1	...	0 2
rand Totals	226 10 3	3,310	1 4.37	226 19 8	2,706	1 7.74	351 18 1	4,868	1 5

Owing to no separate accounts being kept of the timber consumed in each way, the cost of timber in each method cannot be stated, but it would undoubtedly be slightly higher for double-stall than for bord and pillar. The cost of *drawing* timber in the stalls is included in the table under the head of deputy-work.

In comparing the two sets of costs, the average cost of the whole and broken must be taken as the standard of comparison with double-stall. Taking a bord and wall to yield 812 tons, the yield of the pillar when removed by juds can be estimated very nearly in the same manner.*

Thus—63 yards × 39 yards × 1.93 yards ... =4,742 cubic yards.
$4,742 \times 18.83 = \frac{89.292}{20}$ ... ... =4,464 tons.

Deducting ⅛ for loss in broken working ... = 558 „
3,906 „

		£	s.	d.
Now 812 tons × 1s. 7.74d.	=	66	15	8.88
And 3,906 „ × 1s. 5.33d.	=	282	0	10.98
4,718 „		£348	16	7.86

		s.	d.
Then £348. 16s. 7.86d. ÷ 4,718	=	1	5.74
Being the average cost of working the "whole" and "broken." Comparing this with "double-stall"—			
Bord and pillar		1	5.74
Double-stall		1	4.37
Difference in favour of double-stall ...		0	1.37

But this result does not represent all the advantages of the double-stall mode of working the seam in question over bord and pillar, as the percentage of round coal was much higher in the former than in the latter mode of working. There was also another advantage which ought not to be overlooked—namely, that the hewers could produce more coals per shift, as the following particulars, taken over six pays, show:—

Hewers on double-stall produced	3.87 tons per shift.	
Hewers by bord and pillar „	3.49 „	
Difference in favour of double-stall	0.38 „	or 10.88 per cent. more.

---

* See page 243 as to comparative cost of bord and pillar and modified long-wall working, where the manner of calculating these quantities is shown in detail.

Hence under these conditions fewer hewers would be required in pit wholly worked by double-stall to raise a given quantity of coa but a saving in hewers involves a saving in pit-room, and the c on shift and stone work in preparing it. It also embraces a savi in houses and fire coal.

This system of working was found so satisfactory at Epplet that it was adopted in working another seam—the Low Main—

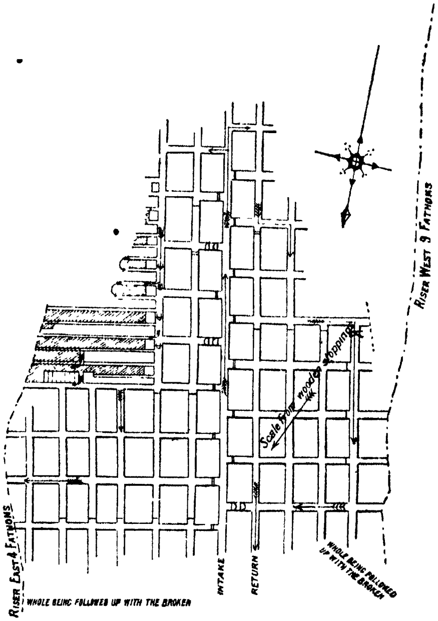

Riser West 9 Fathoms
Scale from wooden stopping
Riser East 4 Fathoms
Whole being followed up with the broken
Intake
Return
Whole being followed up with the broken

Fig. 114.—Plan of Double-Stall Working in Low Main Seam at Elemore Colliery.

Elemore colliery, in the same neighbourhood. Here, at the shaf the Low Main lies at a depth of about 240 yards beneath the surfac and it has the following average section throughout the pit:—

	Ft.	In.	
Good coal	3	6	
Splint coal	0	4	for casting back whic the hewer was pai 1s. 8d. per "score."
Total	3	10	

The workable section, therefore, was about 3 feet 6 inches of good coal. The roof was formed of a bed of arenaceous shale (bastard "post"), and the "thill" of hard black shale (black stone). The inclination of the seam was towards the east, dipping at the rate of 1 in 48. The coal was very strong, gunpowder being used in all the bord and pillar workings when going in the whole.

The manner of working was nearly the same as that in the Maudlin seam at Eppleton colliery, with the exception that the stalls were driven a much greater distance—in one instance, as much as 130 yards—before the working of the ribs was commenced. The reason for this was that a 4-fathom rise fault intersected the seam, as shown in Fig. 114, and to obtain the entire removal of the coal up to this fault the stalls had to be driven a greater distance than usual. The roof stood particularly well, so that when bringing back the ribs very little timber was lost. It was upheld by setting chocks 4 feet apart. As compared with the Maudlin seam at Eppleton, the loss in timber was very small indeed. It took 18 "nogs" to build a chock in this seam, whereas in the Maudlin it required on an average not less than 24 "nogs."

The ventilation was similar to that already described in the Maudlin, except that in some cases the distance the air had to travel was very much shortened by holing through the ribs about half-way up the stall.

Mention has already been made of the hardness of the coal; but although in working by bord and pillar (in the whole) it was necessary to use gunpowder as a means of bringing down the coal when kirved and nicked, no explosive whatever was employed in the double-stall workings, the coal—after it had been kirved across the face—being brought down by driving in steel wedges at the top of the seam. The following table shows the average tons per hewer per shift for six consecutive fortnights in the two ways of working:—

Pay.	Double-Stall.	Bord and Pillar.	
	Tons.	"Whole" Tons.	"Broken" Tons.
1	2.53	1.77	2.47
2	2.27	1.93	2.17
3	2.52	1.93	2.45
4	2.22	2.34	2.59
5	2.48	2.15	2.42
6	2.37	1.75	2.32
General average ...	2.39	1.98	2.40

The percentage of coal lost in working by double-stall was ve low indeed. As it was in the Maudlin seam, so it was here, all coa hewn were sent to bank, no small being left in the pit.

The various kinds of labour employed were the same as tho already described with reference to the Maudlin seam at Eppleto with this exception, that whereas in that seam there was a speci set of men employed to *draw* the timber (chocks), in this case t deputies both drew and set the timber. The hewers kirved, wedge down, and filled all coal, for which they were paid by the sco of 21 tubs, the standard weight of tub being 8 cwt.

		s.	d.		s.	d.	
Double-Stall	In the stalls the score price was	12	4;	+	1	8	for casting back splin
	Do., when forming "stooks" the score price was	14	9				
Bord and Pillar	In the whole the score price was	14	9;	+	1	8	for casting back splin
	In the broken the score price was	11	2;	+	1	8	" "

The yard prices paid throughout the Low Main seam (both i double-stall and bord and pillar working) ran as follows:—

			s.	d.	
Winning headways,	2	yards wide	1	6	per yard.
Do.	3	"	1	4	"
Holing walls	3	"	1	2	"
Wide walls	5	"	0	7	"
Narrow bords	2	"	1	0	"
Bords	3	"	0	8	"
Cross-cut walls	...	... ...	1	4	"
Cross-cut bords	...	... ...	0	10	"

Considering the hardness of the coal, these prices may be regarde as very fair. The following was the cost of getting the coal:*—

Labour.	Double Stall.		Bord and Pillar. "Whole" Working.		Bord and Pillar. "Broken" Working	
	Cost per Ton.	Tons Produced.	Cost per Ton.	Tons Produced.	Cost per Ton.	Tons Produce
	s. d.		s. d.		s. d.	
Yard work	0 0.27	4,218	0 3.04	302	0 0.13	2,612
Incidental charges ...	0 0.65	...	0 0.14	...	0 0.74	...
Total cost for hewing...	1 10.08	...	2 2.57	...	1 8.71	...
Deputy-work	0 0.33	...	0 2.31	...	0 0.26	...
Total cost per ton for getting the coal	1 10.41	4,218	2 4.88	302	1 8.97	2,612

---

* The total cost of hewing was calculated on the total amount, and there fore included the sliding scale percentages existing at that time. These ar excluded in costs given under the Maudlin seam.

The costs were calculated over six pays. In order to properly compare the cost of the two methods, it is necessary to find the average cost of the whole and broken together. Thus—taking a bord and wall to yield 327 tons, and the yield of the pillar when removed by the broken workings to be 1,122 tons—we have—

		£	s.	d.
327 tons	at 2s. 4.88d.	= £39	6	11.76
1,122 „	at 1s. 8.97d.	= 98	0	8.34
1,449 „	... ...	£137	7	8.10

Then £137. 7s. 8.10d. ÷ 1,449 = 1s. 10.75d., being the average cost of working the whole and broken. Comparing this with double stall, we have—

	s.	d.
Bord and pillar	1	10.75
Double-stall	1	10.41
Difference in favour of double-stall ...	0	0.34

Then again there was a gain in produce per man per shift, for by double-stall the produce was 2.39 tons per man, and by bord and pillar 2.30 tons per man, making a difference in tons in favour of double-stall of 0.09, which is 1.8 cwt., or 4.0 per cent.

Advantages and Disadvantages.—These instances of double-stall working go to show that, under the circumstances described, this system in comparison with bord and pillar working may be said to—

(1.) Allow greater concentration of workmen, thus shortening the length of road to be maintained, and lessening the cost of shift and waste work;

(2.) Ensure a more speedy removal of the entire seam in any given area, which is a great advantage where the roof and thill are constantly on the move;

(3.) Increase the output of coal from the same number of men;

(4.) Give a larger percentage of round coal; and

(5.) A larger proportion of the entire seam;

(6.) Enable the coal to be got without explosives, which were found necessary in working the same seam in bord and pillar.

On the other hand, the comparative disadvantages of double-stall working were—

(1.) Increased cost for timber;

(2.) Insecurity of ventilation, the course of the air being dependent on a number of canvas brattice doors, and on the closeness of the fallen stone in the middle of the stall.

At **Celynen colliery**, near Aberdare, the Black Vein seam, lying at a depth of 354 yards, and of an average thickness of about 6 feet, but varying in this respect from 5 feet 6 inches to nearly 9 feet, was worked for some years by double-stall. This method has, however, been abandoned in favour of longwall, with gateways at intervals of 12 yards, and cross-headings every 70 yards. Its advantages over double-stall are found to be—

(1.) A larger proportion of round coal is obtained, 85 per cent. as compared with 70 by double-stall.

(2.) Ventilation is simpler and better.

(3.) There is more room for stowing the rubbish, which includes a good deal of unsaleable small coal. This is more than sufficient to fill up the goaf solid.

An instance of **single-stall working** may be taken from **Yorkshire**, in a case where the seam—the Barnsley Bed—was dipping very heavily, 1 in 3, and working by longwall had been found not to answer. The inclination was "endways," and out of the "endings," which were made into "ginneys," the stalls were turned away at a course of S. 60 W., the level course being S. 85 W. The stalls (or "banks" as they are locally called) were driven 65 links (14 yards) wide, small pillars or stooks, ½ chain square, being left next the ending. The ribs between the banks were left the same width, 65 links. The banks were carried a distance of 3 chains, when they were cut off by another "ending." Only one hewer worked in each bank, and there was only one tramway,* which was laid along the dip side of the bank. The hewer shovelled his coals down the slope into the tub on the tramway. The seam was 6 feet 9 inches thick.

Reverting to **South Wales**, through the kindness of Mr Morgan W. Davies, who has provided us with valuable notes on the subject, we are enabled to describe the manner of working the seams in the West Swansea district by the **single-stall system**. In the district referred to, the coal measures are highly inclined, the angle of inclination ranging from 22° to 50°. The direction of the dip in this part of the South Wales coalfield is north; this being the southern outcrop of the basin. The configuration of the surface is less undulating here than is the case generally over the area of the coalfield, and workings on the outcrops of the measures have not therefore the advantage of cover that would obtain in hilly districts, where the adits or slopes are invariably opened out in the escarped hill-sides which rise almost precipitously.

---

* Hence termed single, not double stall.

The mode of working adopted is shown in the subjoined sketch (Fig. 115). It consists of driving down a slope on the outcrop of the seam and following the coal downwards. Main level galleries about 9 to 12 feet wide (see Fig. 116), depending upon the character of the seam and the roof and floor, are driven outwards east and west at intervals of 20 to 30 yards apart on the slope, from which stalls 5 to 6 yards wide (when fully opened out) are developed to the rise at distances of about 15 yards apart on the main levels. When the main levels have attained the boundary of the royalty or other inbye limit, the pillars are taken out and the coal wrought

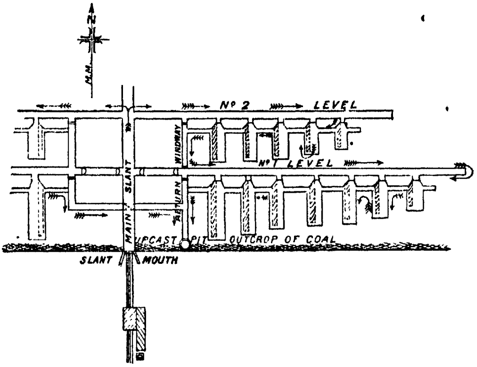


FIG. 115.—SINGLE-STALL WORKING IN SOUTH WALES.

homewards as effectually as possible, and not unfrequently at the expense of the subsidence of the surface, which the colliery lessee is invariably compelled to make good. The thickness of cover at the extremity of the upper range of stalls does not in some instances exceed 8 or 9 feet. There are no tram roads in the stalls. The coal is gravitated down; the stall is always almost full of coal, and so much as is required to fill a corve is liberated at the stall entrance into the tram or corve.

The mode of ventilation will be readily understood from Fig. 115. The current is taken down the slope, and after having made a circuit of the workings, returns to an upcast shaft. Motion is induced at the smaller collieries by furnaces or by carrying the exhausted steam of the underground pumping engines into the return windways, but at one or two of the larger collieries ventilation is effected by Waddle fans, made locally, which perform very good duty, and call for little or no attention in working. The current is carried up the stalls by bratticing, against which the little rubbish that is given off in working is packed. The shallow measures, as a whole, are tolerably free from fire-damp, and the question of ventilation does not therefore receive the attention it deserves.

When the main levels have attained a considerable distance inbye, the return windways are shortened by sinking small upcast shafts on the outcrop, which are generally spaced at intervals of 15 to 20 chains apart.

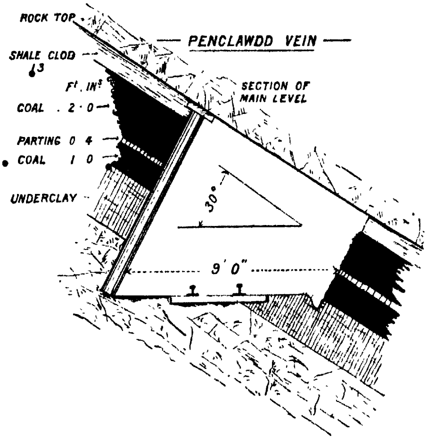


FIG. 116.—SINGLE-STALL WORKING IN SOUTH WALES (CROSS-SECTION OF MAIN LEVEL).

Double-Stall in a Thin Seam.—The system is sometimes found to answer better than longwall. As a case in point, there may be mentioned a Durham colliery working a seam only 2 feet 2 inches in average section,* and having for the roof a strong shale, and the thill hard fireclay. When worked by longwall, the gateways were made at intervals of 12 yards, with packwalls 7 feet wide on each side. The average output per hewer per shift was 3 tons. When working by the double-stall system the stalls were made 12 yards wide, and 12-yard ribs left between them. The stalls were driven a distance of 60 to 80 yards, and then the ribs were worked back. Twice the quantity of coal was got (24 yards), as compared with the longwall (12 yards), for the same amount of "packing" (two packs 7 feet wide). The quantity of coal got per hewer per shift averaged 2 tons 8 cwt. in the stall, and 4 tons in the rib, making, on the whole, more than was obtained by longwall; and the cost of working was about 4½d. per ton cheaper than by longwall.

---

* *Brit. Soc. Min. Stud.*, vol. xv. "Double-Stall Working in a Thin Seam," by Edward Graham, Jun.

Double-Stall in South Wales.—An instance of the successful application of the double-road stall system in South Wales, as carried out at a colliery near Neath, in the working of the Graigola seam at a depth of 433 yards at the shaft, has come under the notice of the authors. The section of the seam is as follows:—

		Ft.	In.	Ft.	In.	
	Top coal	1	1	...		
	Coaly rashings cast back	...		0	11	
	Good coal	2	4	...		
Filled separately—	Inferior coal	0	9	...		
		4	2 +	0	11	= 5 ft. 1 in.

The roof is for the most part a strong hard stone, requiring little timbering. Bottom stone is taken up where height is required. The tubs hold 20 to 25 cwt. The gauge of way is 2 ft. 7½ in.

As shown on the accompanying plan of the workings (see Fig. 117, Plate XXVIII.), the stalls are made 14 yards wide, and the ribs or pillars of coal between them are left 30 yards in width. The space in the middle of the stall between the two roads is filled up closely with the part of the seam which is cast back, and with other "stowing," and the roof does not fall. The seam is not fiery. Four men at a time work in the face of the stall, in sets of two. They are paid 1s. 2d. a ton of coal they get, 3d. a prop for setting timber, and 1d. a prop for drawing it, *plus* the current percentage. Their average output of coal is 3½ tons per man per shift of about eight hours in the face. Little or no explosive is used in getting the coal. The holing, or kirving, is done in the coaly rashings, which is thrown back; then the 1 foot 1 inch and the 2 feet 4 inches of good coal is got; and finally the 9 inches at the bottom, which is filled separately. The distance which the stalls are driven is usually 4 chains. The ribs are brought back in one face for their whole width of 30 yards.

CHAPTER XIV.

ON WORKING TWO SEAMS NEAR TOGETHER.

ONE of the most difficult conditions under which to work coal efficiently is where two seams lie near together, separated from each other by only a small thickness of stone. This is the case at some of the West Durham collieries, where the top Busty seam is separated from the bottom Busty by only a few feet of stone, the thickness varying a good deal. To take an actual instance, the section is:—

		Ft.	In.	Ft.	In.
Top Busty, 2 ft. 8 in.	Coal	0	3	...	
	Band	...		0	3
	Coal	2	2	...	
	Stone	...		12	0
Bottom Busty	Coal	3	3	...	

The depth at the shaft to the Bottom Busty is 50 yards. The main roads are made in the bottom seam, and inclines driven up to the top seam, which is worked off entirely before the lower one is further touched. Experience here goes to prove that where the bottom seam is worked first, the top seam is quite spoilt. Opinions differ, however, on this point. At a neighbouring colliery it is considered best to commence with a first working in the bottom seam, getting a large proportion of it, and leaving pillars only 6 yards wide; then to work off the top seam; and lastly, to remove as much as possible of the pillars left in the other. The truth seems to be that in most cases, and especially when the intervening stone is firm and cohesive, it is certainly best to work the top seam first, allow the roof to settle, and then work the lower seam; but sometimes where the stone is loose and friable, the bottom portion should be first attacked, or otherwise it may be found impossible to work it at all.

In a paper on "Some Methods of Pillar Working in the South

Durham and Cleveland Districts,"* by Mr Wm. Spencer, a case at Woodifield colliery is mentioned, where the Five-quarter, averaging 3 feet 10 inches in section, was 26 yards above the Main Coal, which was 6 feet to 7 feet thick. The Five-quarter was worked both in the whole and in the broken over pillars and over goaf in the Main Coal, and it is stated that "after experience in the different plans, they decidedly prefer working the Five-quarter both in the whole and pillars before commencing with the Main seam."

In a paper by the late Sir George Elliot on "The Effect produced upon Beds of Coal by working away the Over- or Underlying Seams,"† the author states that at Monkwearmouth colliery, near Sunderland, on the northern bank of the Wear, the Maudlin seam lies at a depth of 530 yards, and is 6 feet thick, and the Hutton at 570 yards, 4 feet thick. In working the latter seam in its normal condition it was found to be easily worked, making in the ordinary course of working 50 per cent. of small coal, through screen bars $\frac{5}{8}$ inch apart. The roof was uniformly bad, requiring much timber to support it. But when the workings extended under the Maudlin seam goaf, the conditions were entirely changed. The seam became much harder, requiring the use of gunpowder, and 20 per cent. less small was made. The roof, too, was strong, needing little timber.

At Usworth colliery, in the same county (Durham), the Maudlin seam is 310 yards deep, the Low Main seam 330 yards, and the Hutton seam 350 yards. Here, whenever the workings in the lower seams were carried on below goaf in the upper, the coal became "so hardened and bad to work that it became a difficulty to induce the men to work the coal." Eventually it was found necessary to stop the upper seams and advance the lower, "so as to work the coals entirely out in them before approaching with the workings in the upper seams." In collieries working seams at a less depth—namely, 160 yards—no effects of a similar nature were appreciable. The author's conclusion is as follows:— "Upon a careful review of all the circumstances arising out of the consideration of this interesting subject, I am of the opinion that it will prove to be of permanent advantage to deep coal-mines to work the upper seams first, and so improve the lower beds in hardness."

In working the Main Coal over goaf in the Low Main seam 50 yards below, at Trimdon colliery, in South-east Durham, the Main

---

* *Trans. North of England Inst. of Mining Engineers*, vol. iii.

† *Ibid.*, vol. iv.

Coal was found in some cases to have separated and fallen from the top stone, leaving a space through which men hewing in adjacent bords 20 yards apart could talk to each other. This space above the seam served as a kirving, and no other was necessary.

In a paper by Mr J. J. Jordan on "A Method of Working Two Seams of Coal lying near one another,"* it is shown that the experience gained in the Annfield Plain district of the county of Durham in working the Brass Thill below the Five-quarter (where the latter has been already worked in old times, and thin ribs of coal left 3 yards to 4 yards wide × 30 yards long, the stone between the two seams being fairly good, and varying in thickness from 9 inches to 10 yards), proves that there is more difficulty with the top stone when underneath the old pillars than under the old fallen bords; and Mr Jordan considers that it is best to first work off the top seam entirely, then allow the goaf to settle, and then commence with the lower seam. There is little doubt that this will be found the best plan in most cases.

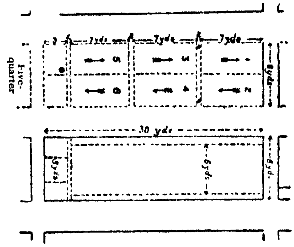


FIG. 118.—SKETCH SHOWING THE WORKING OF TWO SEAMS NEAR TOGETHER.

Sometimes the upper seam is worked simultaneously with the pillar working in the lower seam. In one instance the section was:—

		Ft.	In.	Ft.	In.
Five-quarter	Good coal	2	9	...	
	Splint coal	2	3	...	
Soft band		...		1	0
Brass Thill; good coal		5	1½	...	

The depth was about 56 yards. The Brass Thill was worked in the whole first, the pillars being made 30 yards bords × 8 yards walls. In working the broken they cut up into the Five-quarter from the bord in the Brass Thill at a point about 7 yards back from the inbye end of the pillar, and drove a siding-over (A B, see Fig. 118) 2 yards wide in the Five-quarter. The block of Five-quarter, 7 yards × 8 yards, on the goaf side of the siding-over, was then removed in two bordway lifts (1 and 2, see Fig. 118). The same process of cutting up, siding-over, and working off the lifts is repeated twice, leaving a piece 3 yards × 8 yards to be worked. This is done by driving a jenkin in the Brass Thill pillar 3 yards up from the headways, and breaking up into the Five-quarter, and removing the remaining stooks in it. A jenkin 6 yards wide is then continued up the middle of the Brass Thill pillar, leaving a yard of coal on either side. When the old bords are fallen, the first step is to drive a jenkin 4 yards wide in the Brass Thill pillar.

---

* *Journal of the British Society of Mining Students*, vol. vi.

A great deal of coal is lost, perhaps unavoidably. The reason for making the walls in the Brass Thill only 8 yards is, that in working the Five-quarter, the coals are filled into the tub standing in the Brass Thill bord, and where there are more than 7 yards to cast the coals, extra wage has to be paid for it. It seems to be extremely difficult to work two seams under such circumstances without losing a considerable portion of the coal.

That it is better as a rule to work first the upper of two seams, when the distance between them is inconsiderable, is confirmed by another instance of practical experience recorded by Mr Joseph Carter.* Two seams, which were separated by 20 to 24 yards of strata, were being worked at one time by longwall, the lower seam a little in advance of the upper.

Under these circumstances great difficulties were experienced in working the top seam. Frequently it was found to have fallen away from the roof, and the nature of the coal to be so changed that as much as 9d. per ton extra price had to be paid to the collier; similarly the props and chocks sunk away from the roof, and heavy falls of stone followed.

The longwall system of working was abandoned in favour of bord and pillar, but whenever pillars in the upper seam were worked over goaf in the lower, the same difficulties were encountered.

Experience proved that the working of the upper seam in advance of the lower was most decidedly the best method of proceeding, as being safer; more economical, the actual saving in working cost being sometimes as much as 1s. 3d. a ton; and also as yielding a greater produce of coal per man.

---

* See *Mining*, vol. iii., p. 47.

CHAPTER XV.

THE WORKING OF THICK SEAMS.

Thick Seams of South Staffordshire and Warwickshire.—The conjunction of several seams of coal, to the forming of one thick seam, has in the case of South Staffordshire, and in a part of Warwickshire, led to the development of special systems of working suited to the several conditions there existent, which are well worthy of consideration, for, although the "thick" coal of what may be termed the "exposed" portion of the South Staffordshire field is rapidly being exhausted, it has, as yet, been hardly touched east and west of the great boundary faults, and in the Warwickshire coalfield a large area of a thick coal-bed remains to be worked. Further, a knowledge of the systems of working pursued in these two fields will undoubtedly be of use to those who are engaged in wrestling with similar difficulties in other parts of the world—to name only a few instances: the thick seam in Fifeshire (18 to 20 feet), the Giridih seam in Bengal, India, and the thick seams in some parts of Australia and New Zealand.

The "Thick" Coal of South Staffordshire.—Over a large part of the South Staffordshire coalfield a number of seams—eight to thirteen—come together and rest directly upon one another, or the separate beds are divided by but thin intercalations of dirt or stone, so making up an aggregate thickness of, in some instances, 30 feet of solid coal, termed usually the "Thick" or the "Ten yard" coal. Although this bed, or aggregation of beds, has been worked at a thickness, inclusive of partings, of 34 feet 9 inches,* this is an unusual thickness: 24 feet would be considered a typical section, and frequently it is below 15 feet. The particular section just referred to was as follows:—

---

* At Mr Mills's colliery, near Hawne (see "Geology of the South Staffordshire Coalfield," by J. Beete Jukes, p. 178).

	Ft. In.	Ft. In.		Ft. In.	Ft. In.
1. Roof coal	...	1 6	9. Stone coal	...	3 0
2. Spires coal	...	2 9	Hard parting	0 6	...
3. White coal	...	3 0	10. Patchell's coal	...	2 9
Parting	0 9	...	Batt	0 4	...
4. Fine floors coal	...	1 4	11. Sawyer coal	...	1 4
5. Tow coal	...	3 0	12. Slipper coal	...	4 3
6. Brassils coal	...	1 6	13. Benches coal	...	1 6
Parting	0 6	...			
7. Fine coal	...	2 9		4 1	30 8
Parting	2 0	...			
8. Veins coal	...	2 0	Total with partings		34 9

Systems of Working.—In South Staffordshire two systems, of which there are several variations, are in vogue for working the thick seam. Firstly, that modification of the "pillar and stall" system known as "wide work" and sometimes as "square work," and, secondly, a modification of longwall. The former is most commonly adopted, more especially in cases where the coal constitutes one continuous seam or the intervening layers or bands of dirt are very thin.

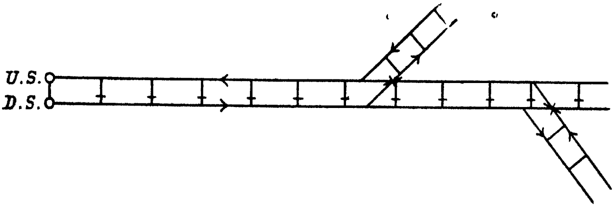


FIG. 119.—DIAGRAM SHOWING RELATIVE POSITIONS OF MAIN AND BRANCH ROADS.

Briefly described, the wide work system consists in dividing the seam up into a number of compartments, termed "sides of work," which are separated from one another by ribs of coal, 8 to 10 yards thick, termed "fire ribs" (see Figs. 120 and 121), the "sides of work" being opened out from the gate-roads, and no more of them kept open at one time than are in active work. As each "side of work" is completed, and the pillars left to support the roof have been thinned as far as is safe, the roads connecting the "side of work" with the gate-roads are sealed up to prevent entrance of air, and so obviate the spontaneous combustion which is so characteristic of this coal. The manner of procedure in opening out a "side of work" will be best explained by the diagrams given below.

Having driven out the main roads a sufficient distance (see Fig. 119), preferably in some thin seam below the thick coal or in some suitable stratum of shale or stone, branch roads—there being the same distance between them as in case of the main roads, that is to say between 35 and 45 yards—are turned away to the right and left, and driven in all probability in the bottom coal to the boundary of the colliery, the idea being to work "home" on the retreating system on account of the difficulties otherwise engendered by crush and spon-

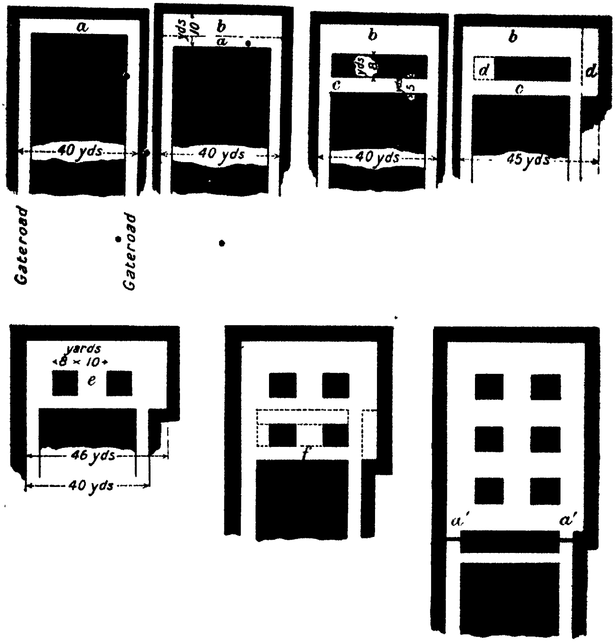


FIG. 120.—DIAGRAMS ILLUSTRATIVE OF DEVELOPMENT OF A "SIDE OF WORK."
Scale, $\frac{1}{8}$th in. = 4 yards.

taneous combustion. When the branch districts have been worked out, the main gate-roads are further proceeded with until they reach the boundary, when work is opened out as in the case of the branch roads, that is to say, the area to be worked is divided up into the large chambers or "sides of work," surrounded on all sides by the fire ribs or barriers of solid coal, through which are but two openings for ventilation and exit of coal and miners.

Opening out a "Side of Work."—Imagine, then, that a pair of gate-roads, driven 40 yards apart, having reached the boundary, it is desired to open out a "side of work." This is done in the following manner:—The gate-roads are holed across as at (*a*), the holing being afterwards widened out to 10 yards by taking off the side coal. While this is being done a second cross-drivage (*c* (3), Fig. 120) is made about 5 yards wide between the two gate-roads, 8 yards back from the first holing, so leaving a block of coal 8 yards wide. The side gate-roads are then "side-laned" off, as at *d*, *d* (4), to 10 yards wide, and a "stall," *e* (5), driven 10 yards wide through the block of coal, forming two pillars 8 yards square.

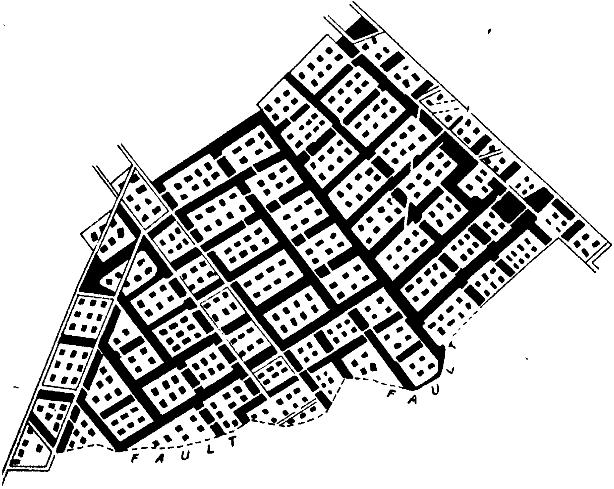


FIG. 121.—PLAN OF PART OF THE WORKINGS OF THE THICK COAL AT SANDWELL PARK COLLIERY. DEPTH FROM SURFACE, 490 YARDS. AVERAGE THICKNESS OF COAL, 17 FEET.
(*Taken from Report of Royal Coal Commission*, 1903.) Scale, 5 chains to 1 inch.

These operations will have been conducted in the bottom coal or at a height of about 6 feet possibly, and the work has been merely a kind of bord and pillar working; but at this stage of the proceedings the upper layers of coal in the back opening will be taken down in sections and in layers, the successive portions of the seam being cut at the side by the "pikemen" standing on the heaps of fallen coal or on light wood staging to cut the upper layers. The coal is "nicked" or grooved along the side of the section which it is intended to take down, and divisions of coal or "spurns" are left in the "nicking," which are cut through in the upper part, afterwards further cut away, and finally knocked out by a pricker. Whilst this top coal is being taken down, a third holing, *f* (6), is made between the two gate-roads at a distance of 13 yards from the last one *c*, and *c* is widened out to 10 yards, the two pillars formed off as previously described, and again a fourth holing made, and the operations repeated until the "side of work" is complete, as in (7); when, after the pillars have been thinned as much as is compatible with safety to the workmen, the chamber will be dammed off at *a′ a′* (7), and a new "side of work" commenced, leaving a rib of coal as a fire rib between this and the preceding side of work.

Fire Dams.—In putting in the fire dams, clay is seldom used, as it does not constitute a reliable dam owing to its cracking as it bakes, and so allowing of the passage of air. Usually a wall is built, behind which is a backing of fine river sand often as much as 10 feet thick, the front of the wall being cemented over.

Fig. 121 shows a series of sides of work as carried out in the thick seam at Sandwell Park Colliery at a depth of 490 yards from the surface, the average thickness of the coal being 17 feet.

Coal left in Working and Further Workings.—Speaking generally, in the *first* working, which has been just described, from 40 to 50 per cent. of the coal is left underground unworked, subsequently about 30 per cent. of the remaining coal is got, as the coal may be worked a second and even a third time ("turned over" three times) when not lying at a depth of more than 100 yards from the surface, in which case often as much as 90 per cent. of the total coal is recovered in all. But a considerable time, often many years, has to elapse between the several workings. In the *second* working considerable difficulty, in the majority of instances, is experienced in maintaining the roof; whilst in the *third* working the roads have to be made through the goaf itself, and are very close timbered, the roof being "slabbed" its entire length; nor can the coal working itself be said to be carried out on any systematic plan, as it practically resolves itself into a search for odd pieces of coal. In depths of less than 300 yards, the ribs and pillars should be recoverable by second and third workings to greater or less extent, such amount being in inverse proportion to the depth. No second or third workings have, so far, been found possible in depths greater than 300 yards, hence down to 300 yards (to which depth second workings may be carried on) it is better to make the pillars and ribs larger than smaller, and below that as small as possible, i.e., to extract as much coal as possible in the one working.

A table, showing the amount of coal lost in working the thick seam by the wide-work system, was drawn up by Mr F. G. Meachem or the recent Royal Coal Commission, from actual working plans upplied by several well-known South Staffordshire coalowners nd mining engineers, and is reproduced on the opposite page.

Modified Longwall.—The adoption of a system of modified longwall, which has been practised in some parts of the South Staffordshire field, has not hitherto been attended with that amount f success that one might have supposed. It consists in forming large pillar and working it back by longwall, leaving round the xtracted pillar a complete fire rib, damming up the openings hrough the same, forming and removing another pillar, and so on.

The fire ribs are from 6 to 8 yards in thickness, and the extracted rea they enclose is larger than that in the case of wide work (pillar nd stall). If the seam is below 15 feet in thickness, it is worked n one getting, but if above that thickness, it is removed in two ettings, the top half being worked out first and the bottom half several years afterwards—six to eight years should elapse between orkings, when the roof will have settled down and be in a state f rest. In the second working a thickness of about 2 feet of coal usually left up to timber too, but in bringing back the workings ome of this "top" coal is recovered. It is claimed that as much s 86 per cent. of the total coal area has been got by this system in ome instances.

Working the Thick Seam at Great Depth.—The problem f working to a profit a thick seam lying at considerable depth from he surface is one which presents great difficulties to the mining ngineer, and the satisfactory solution of which is of the greatest moment to the Midland mining industry, for the rapid progress wards exhaustion of the so-called "exposed area" of the coal-

Number.	Depth in Feet from Surface.	Thickness of Seam in Feet.	Gotten in First Working.	Left.	Measurements left in		Total Worked.	Area of Sides of Work.	Pillars per Side.	Yield per Working.			Total Yield per Acre.	Percentage.		Theoretical Contents of Seam at 1.274 SG. =79.8 lbs. per ft. reduced to 1,400 tons per acre for sale, &c.	Actual Yield per Foot per Acre.	Loss per Foot per Acre.	Loss per Acre.
					Ribs.	Pillars.				First.	Second.	Third.		Coal.	Slack.				
			%	%	%		%	Acres		Tons.	Tons.	Tons.		%	%	Tons.	Tons.	Tons.	Tons.
1.*	300	24 to 30	55 to 65	10.00	...	..	85 to 90	1½	..	16,000	12.000	2,000	30,000	60	40	33,600	1,250	125	3,600
2.	450	24.0	69.39	32.61	20.61	12.00	80.0	1¼	14	,,	10,000	...	26,000	,,	,,	,,	1,083	266	7,600
3.	600	,,	66.40	33.60	25.20	8.40	70.0	1⅛	13	15,000	8,000	. .	23,000	,,	,,	,,	965	241	10,600
4.†	600	,,	57.22	42.78	33.46	9.32	84.0	1¼	...	18,000	10,000	..	28,000	55	45	,,	1,161	239	5,000
5.	900	,,	60.00	40.00	25.00	...	89.0	1⅛	12	,,	8,000	.	26,000	52	48	,,	1,083	317	7,600
6.‡	1,200	,,	62.00	38.00	,,	13.00	62.0	1⅛	10	16,000	...	.	16,000	50	50	,,	666	733	17,600
7.‡	1,500	17.6	60.09	39.01	30.91	9.00	60.0	1¼	7	13,000	. .	..	13,000	45	65	23,600	742	616	10,800
8.‡	1,800	20.0	57.00	43.00	36.00	7.00	57.0	¾	4	,,	.	.	,,	40	60	28,000	650	750	15,000
9.‡	2,100	14.0	54.25	46.75	37.47	9.28	54.25	¾ or less.	5 or less.	to 9.000	.	. .	to 9,000	35	65	19,600	642	755	10,600

* Fine unsaleable slack was left under foot, but is included in measurements, as we are now considering system of work. Had the slack been of any use it would have been drawn out.

† There is a great discrepancy in weights owing to the various weights and parcels sold.

‡ No second working yet tried to my knowledge.

field will necessitate the opening out of the, as yet, little developed "hidden area" where the thick coal exists at considerable depth from the surface. There are only two collieries in South Staffordshire from which data can as yet be obtained on which to base conclusions, viz., the Sandwell Park and the Hamstead collieries, both of which are on the west side of the "exposed" field, although Baggeridge, on the east side, will soon be working the thick seam also. From evidence so far to hand (see No. 8 Table, p. 247) it has been shown that not much more than half of the total coal is recoverable, and of this no less than 60 per cent. is slack when working at and above 2,000 feet from the surface.* Indeed, it is estimated that the relative proportion of the vend to the coal *in situ* is about 43 per cent. If these figures are correct, they show a very serious state of affairs and form much food for reflection.

That the high percentage of slack is not due alone to the pressure of the superincumbent strata is shown by the fact that in thinner seams lying at greater depths (as, for instance, in the southern portion of the North Staffordshire coalfield), and where the overlying strata are similarly constituted to that in the case before us, the amount of "crush" on the coal, as evidenced by the percentage of slack, is very much less. It would seem, therefore, that the pulverising effects are also ascribable to some extent to the inherent tension of the coal itself. At Hamstead colliery these effects are very noticeable, the workings there being much subject to eructations, termed "bumps," occasioned, doubtless, by the release of the tension of the coal by the driving of the roads. The "bumps" are of a very sudden and violent character, occurring

---

* Mr Meachem, in his evidence before the Royal Coal Commission, stated that the proportions of large and small coal obtained under the different systems were as follows :—

Depths of Seam from Surface.	Pillar and Stall.	Longwall.
Down to 100 yards deep	50 °/o coal, 50 °/o slack.	50 to 55 °/o coal, 45 to 50 °/o slack.
200 yards deep	45 °/o coal, 55 °/o slack.	50 °/o coal, 50 °/o slack.
300 to 400 yards deep ...	40 °/o coal, 60 °/o slack.	45 °/o coal, 55 °/o slack.
400 to 700 yards deep ...	30 to 35 °/o coal, 65 to 70 °/o slack.	Not tried to his knowledge.

See also Table on page 247

usually in the floor of the roads driven in the bottom of the thick coal, much destruction resulting to timbering and the roads themselves, large fissures being made in the seam owing to the pressure and the resistance offered to the same by the floor; and there is little doubt, seeing that these fissures contain a certain amount of finely crushed and powdered coal, that the initial heat due to attrition, and the oxidation of the finely powdered coal in the fissures due to leakage of air from the roads by means of cross fissures (*a*, *a*, Fig. 122), are the exciting causes of the spontaneous combustion which here sometimes occurs in the solid coal itself.

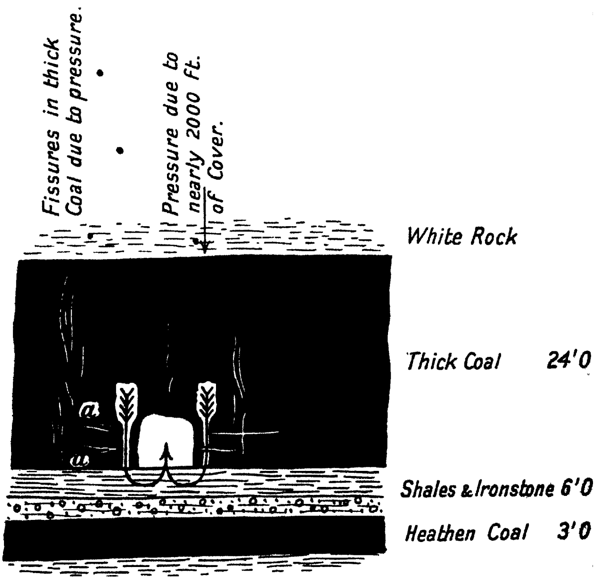

Fissures in thick Coal due to pressure.
Pressure due to nearly 2000 Ft. of Cover.
White Rock
Thick Coal 24'0
a
a
Shales & Ironstone 6'0
Heathen Coal 3'0

FIG. 122.—DIAGRAM ILLUSTRATING PRESSURE ON FLOOR BY ROADS DRIVEN IN THICK COAL. Arrows denote direction of pressure on bottom or floor. *a*, *a* denote side or horizontal fissures connecting with main or vertical fissures.

This, therefore, is an example of "thrust" in its severest form combined with the effects of coal tension. A possible remedy suggests itself to the writers, namely, that of providing an easement to this double pressure by working out a thin seam lying in close proximity to the thick coal, one preferably *below* the thick coal, say the "heathen coal" (see Fig. 122). For, if an upper seam were worked first, it might tend to injure the roof of the thick coal; further, at Hamstead colliery there does not appear to be a seam of coal above the thick coal in near proximity thereto.*

Another Method of Working Thick Seams, or Seams in close proximity to each other, known as the "Hill" System.—Another method of working a thick seam at considerable depth from the surface, for details of which the writers are indebted to Mr J. H. Laverick, is in operation in Warwickshire, and is well worth describing. The seam, which lies at a depth of about 500 yards, averages about 24 feet in thickness, and, like the "thick" coal of South Staffordshire, is due to the coming together of several seams—

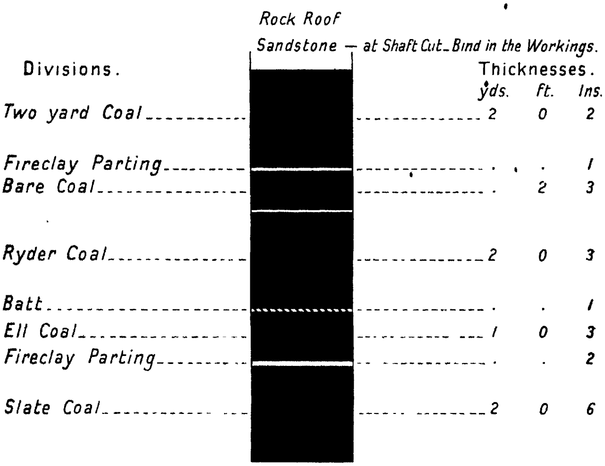


FIG. 123.—"HILL" SYSTEM OF WORKING THICK SEAMS IN WARWICKSHIRE.
The dip of the seam is variable, but in no part is it steep.

---

* The succession of the seams in a typical section of the "exposed" portion of the coalfield is, in descending order:—

1. The brooch coal.
2. The flying reed.
3. The thick coal.
4. The heathen coal.
5. The new mine.
6. The bottom coal.

Mr F. Meachem, who has had great experience in working the thick coal, differs from the writers in that he is of the opinion that the top seams should be worked first, as forming thereby a cushion *over* the thick coal and limiting the force of the "bumps."

perhaps five—but for practical purposes is regarded as having three principal divisions, viz., the "two-yard" coal at the top, then the "Ryder" coal, and, at the base of the seam, the "slate" coal. A detailed typical section is shown in Fig. 123.

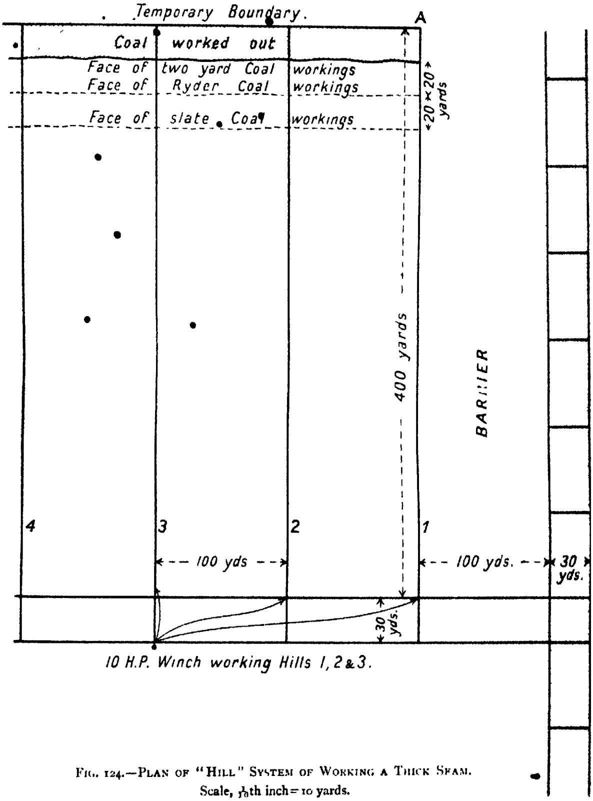

Temporary Boundary.
A
Coal worked out
Face of two yard Coal workings
Face of Ryder Coal workings
Face of slate Coal workings
20 × 20 yards
400 yards
BARRIER
4
3
2
1
100 yds
100 yds.
30 yds.
30 yds.
10 H.P. Winch working Hills 1, 2 & 3.

FIG. 124.—PLAN OF "HILL" SYSTEM OF WORKING A THICK SEAM.
Scale, $\frac{1}{10}$th inch = 10 yards.

The roof at the shaft is good, consisting of sandstone; but in the workings some distance from the shaft the sandstone disappears, its place being taken by a bed of bind, which does no constitute a good cover.

According to the old method of working, in the instance befor us, it was customary to drive the roads in the two-yard coal and work this part of the seam by ordinary longwall, leaving the ryder and slate coals to be attacked by others at some future time. This answered well, no doubt, so long as the roof was a good one, though unquestionably it would have been much more profitable to remove the whole of the coal in one working were that possible, but when succeeded by the bad roof of bind the timber cost would be very heavy, and the more recent method now to be described, and known as the "hill" system of working, is a great improvement on the old, for not only is a greater amount of the seam extracted in the one working but the timber costs are much reduced.

The main winnings are a pair of places driven 30 yards apart, on the full dip of the bed in the lower portion or "slate" coal (see Fig. 124). From these the "district" winnings, or levels are turned away at right angles, and driven, also 30 yards apart, on the line of strike. From the levels, and at right angles to them, the headways, or "hills" as they are locally termed, are turned away at distances of 100 yards from each other and driven to the full dip for about 400 yards, when they are, with the exception of the barriers, holed across as shown in Figs. 124 and 126. Each district is therefore made up of a number of pillars (say seven or eight, inclusive of the barrier) 400 × 100 yards each, formed in each division of the seam. These pillars are then worked back by longwall in each of the three sections of the seam as follows:—

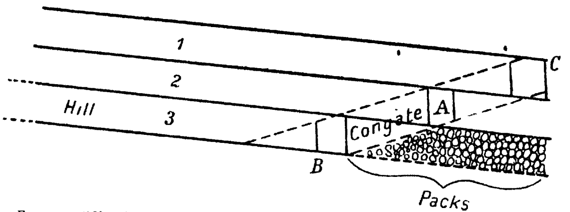


FIG. 125.—"HILL" SYSTEM OF WORKING SECTION, SHOWING ARRANGEMENT OF HOLINGS.
(Not drawn to Scale.)

Longwall is commenced in the bottom seam some little distance back from the temporary boundary AA, and longwall started in the other seams, the respective faces being connected by an inclined road or "congate" (BC, Figs. 125 and 126), and as the workings retreat this road is carried on the packs of the lowest seam and ripped through the other seams if they are not worked. It will be seen, therefore, that there is a small initial loss of coal (which may be afterwards recovered by the workings lower down) in the shape of an angular block of coal left against the boundary. It is desirable to have as little distance as possible between the faces in the successive seams, so as to keep well in advance of gob fires, which are very frequent in this field. It is found practicable, indeed, to advance the face by steps of not more than 20 yards. In this respect we may call attention to the advantage of driving out to the dip and working back on the rise. Heavy though the haulage may be, this drawback is far more than compensated for by being able to work out the coal without fear of gob fires, for the water can be allowed to rise in the goaf behind and extinguish them or prevent their occurrence.

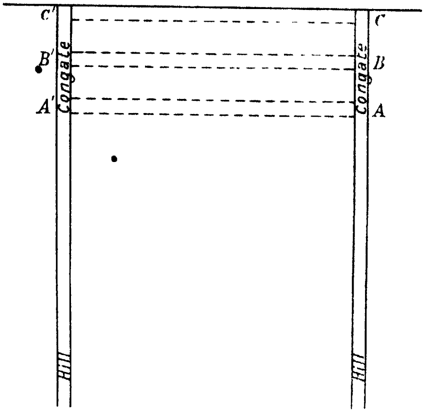


FIG. 126.—"HILL" SYSTEM, DETAILED PLAN OF WORKINGS. (Not drawn to Scale.)
CC'—Holing between Congates in Upper Division.
BB' ,, ,, ,, Middle ,,
AA' ,, ,, ,, Lower ,,

The gob is packed with the bottom stone in which the holing is done, to a large extent by coal cutters, and also with lumps of bad coal (there are bands of inferior coal): the rule observed being that there shall be alternately 2 yards of packing and 5 yards of waste, which ensures the bad coal being sorted out underground.

The labour system for coal getting is that of—(1) stallmen or contractors, (2) holers or getters, (3) fillers. The stallmen being the only men in receipt of payment as from the company, they, of course, being paid by the ton of coal got and by the yard for ripping (where such is necessary), and for sundry extra work, such as cutting a "fast-end," heading by falls, &c. The setting of the timber and putting in of the packs is included in the tonnage (*i.e.* charter) price, the stallmen paying the holers and fillers datal wages for their work.

System of Labour employed in Working the Thick Coal.— The system of labour employed in working the thick coal is very similar to that in operation in longwall workings in the Midlands, with the exception, of course, that there are more loaders in each stall in the former; there is very little "stint" (piece) work in thick coal working. The system may be epitomised as follows:—

1. *Contractors, or stallmen*,—who are paid per ton with a standard price of say 1s. per ton of round coal and 5d. per ton of slack, with percentage on each (at the present time about 40 per cent. above standard), as well as a heading price for driving the roads out to split the work up. Besides seeing to the getting of the coal, the stallman sets the timber and keeps the tubs going. He employs either one or two pikemen and two or three loaders; as a rule three men work at one "band."

2. The *pikeman* gets the coal and keeps the loader going, and in the absence of the stallman sets the timber and otherwise undertakes his duties. He is paid a datal wage by the stallman.

3. The *loader* fills the tubs with the coal, and, if a sufficiently experienced man, is sometimes also employed in getting coal. He also is paid by the day by the stallman.

4. The *fireman* examines stall for gas or fire and for general safety of men, and is paid a weekly wage by the management.

5. The *repairers* are paid a yardage for lowering (bating) the floor, stripping roof, and setting timber; or if at work at a break-down of rock (fall of stone) they are paid either by daywork or on the number of tubs of dirt loaded.

6. The *examiners* are appointed to assist the *firemen* in their morning inspection before the men come in, and are generally picked from the *pikemen* and *road doggies* (hauliers). It is not possible for a man to satisfactorily examine more than two "sides of work," and there are generally three or four "sides of work" in a district.

The getting of the bottom part of the coal, or "undergoing" as it is locally termed, is not very profitable to the stallmen, so that the colliery company has often to advance them money on account, deducting the sum lent when they get (drop) the top coal.

CHAPTER XVI.

WORKING OF WELSH STEAM COAL SEAMS.

Peculiar Structure of Welsh Coal Seams.—The steam coal seams and the anthracite seams of South Wales are different from most others in the presence in them of numerous smooth partings known as "slips," extending right through the seam from floor to roof, and inclined at an angle with the floor and roof.

When a working place is advancing so that the slips make an obtuse angle with the roof, and slope away from the man towards the floor, he is said to be working on the "face" of the slip, and when coming in the opposite direction, he is on the "back" of the slip (Fig. 127). The thinner anthracite seams work best on the "face" of the slips, and for working on the "back" a higher hewing price amounting to 1d. to 2½d. a ton is often paid; but in the thick seams the advantage is rather the other way, especially where there are some inches of soft stone or "clod" above the seam. In the steam coal seams it is the rule for the same price to be paid for hewing, whether working on the face or back of slips.

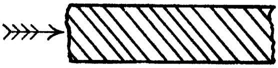
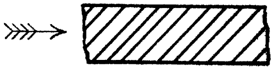


FIG. 127.—ADVANCING ON FACE SIDE OF "SLIPS."



DITTO ON BACK SIDE OF "SLIPS."

This peculiarity of structure renders the seams easy to hew; the coal falls readily in large blocks, holing or shearing is unnecessary, and as a rule no shot-firing is required. Consequently these seams are not suitable for the use of longwall coal-cutting machines;

as owing to these numerous slips it is difficult to keep a face quite straight, and also the coal tends to fall on the machine.

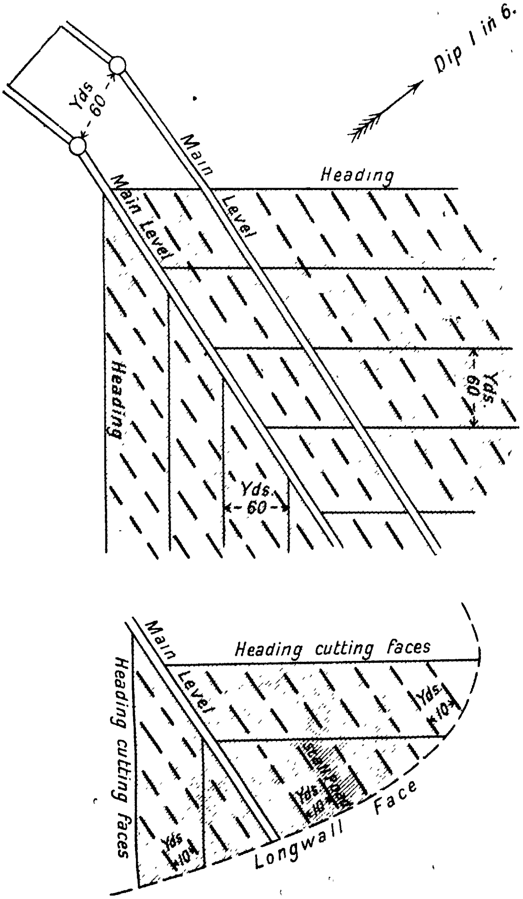


FIG. 128.—SKETCH SHOWING METHOD OF WORKING STEAM COAL SEAM.

Longwall in South Wales.—Apart from this peculiarity, and also that the seams are lying generally at a gradient of 1 in 6 or more, the general system of working them by longwall is much the same as in other districts (see Fig. 128). The main roads are driven out on water-level course, and branch roads or headings are turned away at certain intervals and driven "half" course. From these branch roads the longwall faces are opened out, advancing either on the level or to the rise. All the coal is removed outside the shaft pillar, the roads being maintained through the gob.

The general system is to make the stall roads (or gateways) into the face at intervals of 10 or 12 yards, even in seams of 6 feet or more in thickness. The tram is taken to the face, and the coal filled into it on the stall road. The gob between the stall roads is stowed tight by the collier, and the stowing kept close up to the coal face. After the stall has been cut off by the heading, the stall roadway is stowed up with rubbish. Long continuous faces are kept hundreds of yards in length, not straight, but on a gradual curve. The curve seems to be determined by the way the slips run, and the gradient of the seam.

The timbering in the face consists usually of single props set "off and on," not in straight rows, and "cogs" at the sides of the stall roads. A good deal of the back timber is lost.

There are several collieries in the South Wales coalfield working on the Nottingham, or what is locally known as the "Barry," system of longwall. Here the trams are taken along the face, and the roadways are driven at intervals of 80 to 100 yards. This system is principally adopted where the measures are lying fairly horizontal, the roof generally strong, and the seam yielding a considerable amount of rubbish in the faces.

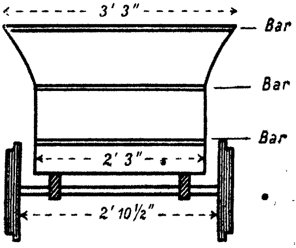


FIG. 129.—TRAM USED IN WELSH COLLIERIES.

Fig. 129 shows the tram commonly used in Welsh collieries. Its dimensions over all are:—Length, 6 feet; width at bottom, 2 feet 3 inches; at top, 3 feet 3 inches; depth, 2 feet; weight, empty, 9½ cwt. Gauge of way, 2 feet 10½ inches. Carrying capacity, 25 cwt. to 2 tons of coal when properly built up with large coal above the top of the tram. It is open at the ends except for the three bars shown in the illustration. Large lumps of coal are built up next these bars, so as to prevent the smaller coal from falling out. At some collieries trams with closed ends are now being used.

In each stall, consisting of 10 or 12 yards of coal face, extending 5 or 6 yards on each side of the stall road, two men are employed, a collier and an assistant, the latter being not less than sixteen years of age. The assistant is paid by the collier about 3s. 2d. a shift. These men do all the work in the face, including the timbering and packing and ripping stone and laying way on the stall road. A price per ton is fixed for large coal passing over a 1¼-inch screen, another for "through" or unscreened coal, and other prices for ripping stone, setting timber, &c.

To take an actual instance of a six-foot seam, the cutting price on large coal is 1s. 1½d. per ton, plus the current percentage, which also has to be added to the following basis prices:—

Ripping top stone up to 18 inches thick, 1d. per inch per yard.
" " above 18 " 1½d. " "
Setting cogs, 1s. 4d. each. Props, 3d. Double timber, 1s. 2d.
Flats (a plank with props), 1s. 0½d.
"Clod" up to 12 inches thick paid by "consideration."
"Rib" at one side, 1s. a yard.
Unloading rubbish, 4d. per tram.

In a six-foot seam with trams holding about 22½ cwt. of coal, the average daily output per stall (two men) runs 5 to 6 trams of large coal, say 6 tons, or when filling "through" coal about 8 trams, say 9 tons. When the small coal is not wanted, it is cast back into the "gob." Of the coal the men fill as "large" coal, 65 to 75 per cent. passes over the screen, and on this they are paid.

When the collier is paid on the large coal scale, the small is supposed to be thrown back into the gob, and any small sent to the surface is deducted from the gross weight of mineral passed over the machine to arrive at the net weight of large coal.

A usual rate of advance of a longwall face in a six-foot seam working single shift is about 4 yards or 12 feet a fortnight.

The stall roads are cut off by cross-roads at intervals of 50 to 60 yards. The interval is determined by the nature of roof, and should be such that one ripping only is necessary before the stall road is cut off by the cross-road.

The permanent roads require several "rippings." They usually need to be cut out of the solid stone above the seam before they will stand. In some of the deeper pits the crush on the roads is very severe, and causes much expense. A large staff of repairers has to be employed, and the cost of this work is often 1s. to 1s. 6d.

a ton. Much of it is done on "bargain" price (piece work), and the men make good wages, up to 8s. a shift.

The double-stall system of working is largely practised in South Wales, especially in the bituminous coal collieries. An instance of this is described at page 236; and No. VII. scheduled in Chapter XVII. is another instance.

The schedule of prices agreed on for working the seam in No. VII. example is as follows:—

			s.	d.
1.	Cutting through coal, irrespective of thickness	per ton	1	8
2.	Gobbing holing where requested by management, per ton	extra	0	2
3.	Opening out stalls from heading to full width	each	8	0
4.	Making shafts for carting stalls		9	0
5.	Carting after first five yards	extra per ton	0	2
6.	Cutting clay in carting stalls, 11 feet wide, first 12 inches, per inch per yard		0	1
6*a*.	Cutting clay in carting stalls, 11 feet wide, after 12 inches, per inch per yard		0	1½
6*b*.	Splitting clay in carting stalls, 11 feet wide, 12 inches thick, per inch per yard		0	2
7.	Shifting coal back after first 6 yards	extra per ton	0	1
8.	„ „ uphill in stalls, first 6 yards	„ „	0	2
9.	„ „ „ „	for each succeeding yard	0	1
10.	Stalls, with 2 fast ribs	per yard	1	0
11.	Pillars left behind at manager's request exclusive of first 10 yards from airway		1	0
12.	Driving airways, first 10 yards	per yard	1	6
12*a*.	„ „ each succeeding 10 yards	extra „	0	6
13.	Double shift in stalls and skips	extra per ton	0	2
14.	Driving narrow or wide headings, 8 feet wide	extra per yard	6	0
15.	Double shift in headings	„ „	1	0
16.	Three men in headings	„ „	0	6
17.	Walling waste for airways	„ „	0	6
18.	Road props in headings, 6 feet or 9 feet	each	0	6
19.	All road props in stalls	„	0	4
20.	Cogs stood on clay	„	1	3
21.	„ „ hard bottom	„	1	9
22.	Standing flats	„	1	0
23.	Double timber	per pair	2	0
24.	Tumbling places where required	each	2	0
25.	Colliers performing day work	per day	5	0
26.	Discharging rubbish	per tram	0	3
27.	Hauliers	per day	4	3
28.	Hauliers in wet places	„	4	6
29.	Tippers	„	3	10

A list of prices paid in working an anthracite seam is also appended. The seam runs about 3 feet thick good coal, and is lying at a gradient of 1 in 4 to 1 in 6. It is worked by longwall with 15 yard stalls. These prices show the importance of the "slips" which are peculiar to these seams, described at p. 111. The list reads as follows:—

"The following prices are agreed upon by the undersigned to be paid for working the Pumpquart vein:—

			s.	d.
"1.	Cutting large coal, face side	per ton	1	8
2.	" " back side	"	1	9
3.	Cutting through coal, either side	"	1	2½
4.	Culm	"	0	6
5.	Sticking coal to be mutually arranged between managers and workmen.			
6.	Heading cut, narrow levels, face side	per yard	2	0
7.	" " back side	"	3	0
8.	Opening out from narrow to wide (*a*) gradually	"	2	0
	(*b*) straight up ...	"	2	0
	(*c*) straight down ...	"	3	0
9.	Long cut in stalls	"	1	2½
10.	Square " "	"	0	11
11.	" " skips	"	0	9
12.	Heading tophole in solid	"	3	0
13.	Ripping top in levels, stalls, and other headings to be paid at the rate of 1½d. per inch per yard, forward measurement	per inch	0	1½
14.	Clod to be paid by an extra price per ton on coal as follows:—			
	When clod is 4 inches thick	per ton	0	1
	" " 7 "	"	0	2
	" " 10 "	"	0	3
	And over 10 inches in the same proportion.			
15.	Deep headings in solid and opening out work ...	per yard	3	9
16.	" " not in solid " " ...	"	1	5
17.	Slopes in solid " " ...	"	2	9
18.	" not in solid " " ...	"	1	2½
19.	Walling waste, per side	"	0	6
20.	" topholes, per side	"	1	0
20*a*.	" slants	...	1	0
21.	Pass by for trams	each	2	0
22.	Timbering on levels	per pair	1	8
23.	" topholes	"	0	10½
24.	Nogs alongside levels and slants	each	0	6
25.	Props under top, above clod, levels, and slants	"	0	3
26.	Cogs, usual height	"	1	6
27.	Double shift in narrow places...	per yard	1	0
28.	" " wide places	per ton	0	2
29.	Props taken out	each	0	3
30.	Changing trams to be mutually arranged between manager and men.			
31.	Competent men working on consideration	per day	4	7
32.	Unloading rubbish	per tram	0	6

33. Percentage on or off this list to be subject to advances and reductions as per agreement dated.
34. House coal to workmen to be a settled and fixed price of 1½d. per cwt. for small coal from screens.
35. Permission to be given to the workmen's committee to examine any working in dispute when requested by either employer or workmen.
36. Carting coal, same payment as in Stanllyd."

These price lists, customary at Welsh collieries, are more complicated and troublesome than those in most other mining districts.

CHAPTER XVII.

CONDITIONS AND RESULTS OF WORKING IN DIFERENT DISTRICTS COMPARED.

Local Variations in Method of Working.—Considering the close proximity of the coalfields of Great Britain, it is remarkable that so much variation should exist in the arrangements of labour and the systems of working.

Each district—especially the older districts, as Northumberland and Durham, and Staffordshire and South Wales—has developed its particular system under the stress of local conditions and requirements, and in the main independently of the others.

It is interesting and not unprofitable to inquire how far do these local peculiarities tend to economical production and general efficiency. For instance—

Is it better to subdivide the labour in the coal face, having one set of men to hew the coal, another to set the timber, another to make height and build packs: or to put it all into the hands of one set?

Is it better that each man should be paid independently, or that several should share together?

Does the "butty" or "contractor" system conduce to economical working?

What length of shift tends to the greatest efficiency?

How may the shifts of the different classes of labour be best arranged relatively to one another?

What size of coal tub gives the best result?

With a view to throwing light on such questions as these, the authors have obtained detailed particulars of the labour employed the number of men in each class, the wages paid, the hours worked, &c., and the results obtained in output and cost of working at fairly typical collieries—eleven in number—in some of the principal districts.

These collieries included (1) and (2) two Northumberland steam coal collieries; (3) a Durham coking colliery; (4) a Durham gas coal colliery; (5) an East Durham gas and house coal colliery; (6) a Welsh steam coal colliery; (7) a Welsh bituminous coal colliery; (8) a Warwickshire colliery; (9) a Staffordshire colliery; (10) a Nottingham house, steam, and manufacturing coal colliery; and (11) a Yorkshire house and coking coal colliery. The particulars ascertained have been scheduled as follows (pp. 264-285):—

No. I.—NORTHUMBERLAND STEAM COAL COLLIERY.

Output per fortnight	13,202 tons.
Number and Nature of Seams worked	Five. Hard coal, requiring to be shot down, after kirving, even in longwall faces.
Average Thickness of Coal	5 feet (2,608 tons), 3 feet 6 inches (3,207 tons), 4 feet 6 inches (4,570 tons), 2 feet 8 inches (2,046 tons), 2 feet 5 inches (771 tons).
Gradient	About 1 in 7 usual. Some level. Workings to the rise. 30 self-acting inclines.
Method of Working	5 foot seam, bord and pillar. 3 foot 6 inch seam, bord and pillar. 4 foot 6 inch seam, bord and pillar. 2 foot 8 inch seam, longwall, with gateways 12 to 15 yards apart. 2 foot 5 inch seam, longwall.
Stock of Coal tubs	1,020.
Weight of Coal per Tub	8⅛ cwts.
Number of Coal-drawing Shafts	Two.
Depth ,, ,,	90 yards and 160 yards.
Hours of Coal Drawing	10 hours daily, 7 A.M. to 5 P.M., for 10 days a fortnight.
	10 ,, 4 A.M. to 2 P.M., ,, 1 ,,
	110 hours for 11 ,,

Labour Employed—

		Number.	Relative Proportion.	Net Earnings per Shift including % (18¾).	Length and Number of Shifts per fortnight.
			Per cent.	s. d. s. d.	
Below	Hewers	400	49	6 7 —	Eleven 7-hour shifts.
	Stonemen and Shifters	127	16	3 9 to 8 0 (piece-work)	Nine 8-hour and three 6-hour.
	Putters	54	7	6 0 —	Eleven 10-hour.*
	Drivers and other Boys	168	20	1 7 to 4 5	,, Boys below 16, laid idle to comply with Act.

	Deputies	27	3	5 9 —	Eleven 8-hour and one 6-hour.
	Various—Wastemen, Rolleywaymen, &c.	37	5	3 9 to 6 0	Eleven 10-hour.
	81 per cent.	813	100		
Surface	19 ,,	180			
Total	100 per cent.	993			

		s. d.	Per cent.	
Cost per ton†	Hewing	2 1.6	58	
	Other Labour below	1 6.36	42	
		3 7.96	100	
	Surface	6.82		Includes cost of haulage of coal about 2 miles on surface to shipping harbour, but no shipment charges.
		4 2.78		

Shift	3 tons.
out per hand employed below	1.47 ,,
Average Daily Output per hand employed below and surface	1.20 ,,

* According to Home Office statistics, there are 10,000 boys under 16 years of age employed at Northumberland and Durham collieries. In compliance with the Coal Mines Regulation Act, these boys do not work more than 54 hours in any one week, nor 10 hours in any one day.

† Except when otherwise stated, the costs per ton in these examples are calculated on the output.

N.B.—Most of the men in Northumberland and Durham are supplied with houses free of rent, and with fire coal. The money value of this is calculated to be 9d. a shift. At Northumberland steam coal collieries, a house is required for about every 2 tons of daily output. For 1,000 tons a day, or 11,000 tons a fortnight, a capital expenditure on building houses is required of about £75,000 (£150 a house).

No. II.—NORTHUMBERLAND STEAM COAL COLLIERY.

Output per fortnight	12,800 tons.
Number and Nature of Seams worked	Two. Hard coal.
Average Thickness of Coal	2 feet 7 inches (7,250 tons), 4 feet 9 inches (5,550 tons). No gas nor dust.
Gradient	Slightly undulating.
Method of Working	In 2 foot 7 inch seam, longwall, with gateways at 11 yards intervals. In 4 foot 9 inch seam, bord and pillar, at present working the pillars. Not much pressure on roads; not costly to maintain.
Stock of Coal tubs	In 2 foot 7 inch seam, 350. In 4 foot 9 inch seam, 350. Total, 700.
Weight of Coal per Tub	11½ cwts. 13 cwts.
Number of Coal-drawing Shafts	One.
Depth " "	250 yards.
Hours of Coal Drawing	*11 hours daily, 6 A.M. to 5 P.M., for 10 days. 10 " 5 A.M. to 3 P.M., " 1 " } 120 hours for 11 days a fortnight.

Labour Employed—

Below	2 foot 7 inch seam (longwall). Day.	Night.	Total.	Per cent.	Usual Length of Shift. Hours.	In 4 foot 9 inch seam (pillar working). Day.	Night.	Total.	Per cent.	A.M. P.M.
Hewers	200	20	220	44	Fore 7½ Back 7	97	14	111	40	Fore Shift, 3.30 to 11.0. Back " 10.0 " 5.0.
Stonemen and Shifters	137	9	146	29	8	71	10	81	29	
Putters	18	2	20	4	10	11	1	12	4	
Drivers and other Boys	54	6	60	12	10	19	12	31	11	

Deputies and Chargemen	18	2	20	4	8	11	5	16	
Various — Wastemen, Rolleywaymen, &c.	28	2	30	7	8	26	1	27	10
	455	41	496	100		235	43	278	100

	Total Hands Employed		Below	774	83 per cent	
Surface	Banking, &c.	98	Surface	163	17 ,,	Includes men required to keep in repair colliery houses and to do the scavenging.
	Mechanics, &c.	65				
Total		163		937	100	

Cost per ton - In 2 foot 7 inch seam—

	s.	d.	Per cent.		Per cent.		s.	d.	
Hewing	2	1	51	Hewing price, 1s. 10d. a ton (including per cent.) for a height of 2 feet 7 inches. Other prices for "Ramble," &c.	50	Hewing	1	5½	Hewing price 1s. 2.8d. per ton (including per cent). Other prices for "Ramble," Yard Work, &c.
Other Labour	2	0	49		50	Other Labour	1	5½	
	4	1	100		100		2	11	

Surface	Banking and Screening	3.2d.		(A good deal of "dirt" picked out of coal.)
	Mechanics, Enginemen, &c.	3.8d.	7d.	

Tons per Hewer per Shift	In 2 foot 7 inch seam, 3 tons. Over both seams, 3.51 tons. In 4 foot 9 inch seam, 4.54 tons.
Average Daily Output per hand employed below	1.50 ,,
Average Daily Output per hand employed below and surface	1.24 ,,

---

* *N.B.*—At all Northumberland and Durham collieries, the hours of coal-drawing include time occupied in sending down the men and boys in the morning at 6 A.M., and in changing the shift of hewers about 10 A.M. This occupies usually 1 hour to 1½ hours, and reduces the hours of coal-drawing

No. III.—DURHAM COKING COLLIERY.

Output per fortnight	6,880 tons.
Number and Nature of Seams worked	Two. Soft coal easily hewn. Got mostly as "Small," "Round" coal not being wanted.
Average Thickness of Coal	1 foot 10 inches (2,959 tons), 4 feet 6 inches (3,921 tons).
Gradient	Slight. 1 in 30 maximum.
Method of Working	1 foot 10 inch seam, longwall. 4 foot 6 inch, bord and pillar.
Stock of Coal Tubs	870.
Weight of Coal per tub	9 cwts.
Number of Coal-drawing Shafts	One.
Depth ,, ,,	140 yards.
Hours of Coal Drawing	10 hours daily, 6 A.M. to 4 P.M., for 10 days a fortnight. 9 ,, 4 A.M. to 1 P.M. ,, 1 ,, 109 hours for 11 ,, (Includes sending down men and boys, and changing the shift of hewers.)

Labour Employed—

		Number.	Per cent.	Net Earnings per Shift (including % 28¾). s. d. s. d.	
Below	Hewers	207	44	6 0 —	7 hour fore shift, 4 A.M. to 11 A.M., 6 ,, back ,, 10 A.M. ,, 4 P.M., 11 days per fortnight.
	Stonemen and Shifters	125	27	3 10 to 6 8	Eleven 8-hour shifts, and one 6-hour shift, 94 hours.
	Putters	45	10	3 9 ,, 4 8	Ten 10-hour shifts, and one 9-hour shift, 109 hours.
	Drivers and other Boys	45	10	1 6 ,, 2 6	,, ,, ,, Boys below 16, laid idle to comply with Act.

Deputies	16	3	face 6 0½ backbye 5 4	Eleven 8-hour shifts, and one 6-hour shift, 94 hours.
Various—Wastemen, Rolleywaymen, &c.	30	6	3 0 ,, 5 6	Ten 10½-hour shifts, and one 9½-hour shift, 114½ hours.
92 per cent.	468	100		

Surface	8 ,,	39
Total	100	507

"Fitting" is done at central shops away from colliery, nor are masons included.

		s.	d.	Per cent.
Cost per ton	Hewing	1	11.21	48
	Other Labour below	2	0.77	52
		3	11.98	100
	Surface	0	2.42	
		4	2.20	

Tons per Hewer per Shift	3 tons.
Average Daily Output per hand employed below	1.33 ,,
Average Daily Output per hand employed below and surface	1.23 ,,

No. IV.—DURHAM GAS COAL COLLIERY.

Output per fortnight	5,254 tons drawn, less 425 tons (colliery consumption and workmen's coal), eaves 4,829 tons saleable, on which the costs per ton are calculated.
Number and Nature of Seams worked	Two. Soft coal, sold as gas coal, round coal not required.
Average Thickness of Coal	4 feet 2 inches (3,415 tons), 4 feet (1,839 tons).
Gradient	Usually about 1 in 30.
Method of Working	All bord and pillar working. Pillars 33 yards by 22 yards. Some square, 33 yards by 33 yards. About 70 per cent. of output from pillar working. Workings extensive and scattered, and most of them more than a mile from the shaft.
Stock of Coal Tubs	610.
Weight of Coal per tub	8 cwts.
Number of Coal-drawing Shafts	One.
Depth ,, ,,	120 yards.
Hours of Coal Drawing	10 hours daily, 6 A.M. to 4 P.M., for 10 days a fortnight. 8 ,, 5 A.M. to 1 P.M., ,, 1 ,, 108 hours for 11 ,,

Labour Employed—

		Number.	Per cent.	Net Earnings.	
Below	Hewers	97	39	5s. 8d.	Hours the same as in Instance No. III.
	Stonemen and Shifters	53	21	3s. 10½d., 4s. 7½d., 8s. (piece).	
	Putters	22	9	4s. 2d.	
	Drivers and other Boys	41	16	1s. 8d. to 3s. 4d.	

Deputies		12	5	Face, 6s. ; backbye, 5s. 4d.
Various—Wastemen, Rolley-waymen, &c.		24	10	3s. 9d. ; 4s. 5d. Onsetter, 6s. 9d. (piecework).
	79 per cent.	249	100	
Surface	21 ,,	67		
Total	100	316		

		s.	d.	Per cent.	
Cost per ton	Hewing	1	3.26	48	
	Other	1	4.45	52	
		2	7.71	100	
	Surface	0	7.41		Includes care of houses.
		3	3.12		

Tons per Hewer per Shift	4.84 tons.
Average Daily Output per hand employed below	1.92 ,,
Average Daily Output per hand employed below and surface	1.51 ,,

N.B.—This instance shows that in spite of a small output and scattered workings, coal may be economically produced. The total c at the pit, including cost of materials, rents, rates and taxes, and all expenses, is below 5s. a ton on the saleable coal.

No. V.—EAST DURHAM GAS AND HOUSE COAL COLLIERY.

Output per fortnight	13,155 tons, less 1,547 tons (colliery consumption, and workmen's coal and stones and dirt), leaves 11,608 tons saleable, on which the costs per ton are calculated.
Number and Nature of Seams worked	Three seams. Chiefly gas coal, some "house," and a little "forge." Hard seams requiring "shooting." 7,000 shots fired per fortnight. Safety lamps.
Average Thickness of Coal	3 feet 6 inches (6,840 tons, about 40 per cent. of this is round, and goes as house coal): 4 feet 8 inches (5,525 tons, all gas coal); 2 feet 9 inches (790 tons forge coal).
Gradient	Generally about 1 in 30.
Method of Working	The 3 foot 6 inch and 2 foot 9 inch seams are worked longwall with gateways at 15 yard intervals. The 4 foot 8 inch seam, bord and pillar. Pillars 33 yards by 22 yards, and 40 yards by 30 yards.
Stock of Coal Tubs	1,156.
Weight of Coal per tub	8 cwts.
Number of Coal-drawing Shafts	Two. About a mile apart.
Depth ,, ,,	One, 250 yards deep, drawing 900 tons daily; the other, 176 yards deep, drawing 300 tons daily.
Hours of Coal Drawing	10 hours daily, 6 A.M. to 4 P.M., for 10 days a fortnight. 8 ,, 4 A.M. ,, 12 P.M., ,, 1 ,, 108 hours for 11 ,,

Labour Employed—

		Number.	Relative Proportion. Per cent.	Net Earnings per Shift. s. d.	s. d.	A.M.	
Below	Hewers	436	44	6 6	—	Fore shift, 4 to 10.45 A.M. Back ,, 9.30 to 4 P.M.	Ten shifts, 6½ to 7 hours; one shift, 5½ hours.
	Stonemen and Shifters	239	24	3 10 and	4 8	Stonemen, Shifters, and Wastemen, usually 86 hours a fortnight.	

Putters		53	6	5 0	—	Putters 108 hours a fortnight.
Drivers		56	6	1 8	—	
Deputies		29	3	Face. Backbye,	6 0 5 4	7½ hour shifts in the face 8 ,, ,, backbye } 11 or 12 shifts a fortnight.
Various—Wastemen, Rolleywaymen, Onsetters, &c.		172	17	4 0	—	Onsetters and Rolleywaymen, 10½ hour shift, about 114 hours a fortnight.
	82 per cent.	985	100			
Surface	18 ,,	207				Two screening establishments, and a large amount of dirt picked out of coal. Surface labour includes keeping houses in repair and scavenging.
Total	100 ,,	1,192				

		s. d.	Per cent.	
Cost per ton	Hewing	2 7.14	56	These costs are taken on the saleable coal, not on the gross output.
	Other Labour	2 0.70	44	
		4 7.84	100	
		0 8.77		
		5 4.61		

Tons per Hewer per Shift	2.84 tons.
Average Daily Output per hand employed below	1.21 ,,
Average Daily Output per hand employed below and surface	1.00 ,,

No. VI.—WELSH STEAM COAL COLLIERY.

Output per fortnight	19,000 tons. Total drawn, large and small.
Number and Nature of Seams worked	One. Gassy and dusty. Water spray jets on roads.
Average Thickness of Coal	6 feet 6 inches. Full of "slips." No shooting nor holing required.
Gradient	About 1 in 9.
Method of Working	Longwall. Stall roads at 10 yards intervals, level course. Heavy pressure on roads; costly to maintain. About 700 tons of timber used each fortnight. About 20 per cent. of the coal is left below.
Stock of Coal Tubs	750.
Weight of Coal per tub	2 tons.
Number of Coal-drawing Shafts	Two. Downcast and upcast.
Depth	760 yards.
Hours of Coal Drawing	10 hours daily, 7 A.M. to 5 P.M., for 8 days a fortnight. (Some coal drawn at nights also to clear the roads.)
	7 ,, 7 A.M. to 2 P.M., ,, 4 ,,
	108 hours for 12 ,,

Labour Employed—

		Day.	Night.	Total.	Per cent.	Net Earnings per Shift. s. d. s. d.	
Below	Colliers	360	96	456	35	8 0 —	(Includes 43¼ °/₀ on basis rates.) For coal-getting, colliers are paid on large coal only (*i.e.*, what passes over 1½ inch bar screens), 1s. 7.4d. (including °/₀). Other prices are paid to colliers for ripping (cutting stone) and timbering, &c.
	Repairers and Rippers	251	175	426	33	5 4 to 7 2	
	Hauliers	73	51	124	10	5 0 —	
	Wallers and Labourers	86	74	160	13	2 10 to 4 4	

Firemen	8	7		15	1	7 2	—	About 70 per cent. of what comes to bank is "large."
Various—Airways, &c.	56	51		107	8	—	—	
	834	454	90 °/₀	1,288	100			
Surface			10	142				
Total			100	1,430				

		s. d.	s. d.		
Cost per ton	Colliers, Hewing	1 7.4	—	30	These costs are on the large coal, *i.e.*, about 70 per cent. of the gross drawings.
	,, Other work	0 10.6	2 6	17	
	Remainder		2 10	53	
			5 4	100	
	Surface		10.5		
			6 2.5		

Tons per Collier per Shift	3.5 tons.	These tonnages are calculated on the gross drawings, large and small.
Average Daily Output per hand employed below	1.22 ,,	
Average Daily Output per hand employed below and surface	1.10 ,,	

***N.B.*—This instance shows that in the steam coal seams of South Wales, the cost of hewing is relatively low, but the cost of other labour is high, owing partly no doubt to the heavy crush on the roads.**

No. VII.—WELSH BITUMINOUS COAL COLLIERY.

Output per fortnight	5,563 tons.
Number and Nature of Seams worked	One seam: soft coal. No shooting nor holing. 70 per cent. of produce is small, over a 2¼ inch bar screen.
Average Thickness of Coal	2 feet 8 inches. A little gas. No dust. All coal sent out.
Gradient	1 in 6 to 1 in 4 dipping inbye. Seam crops out at surface. Won by day drifts.
Method of Working	Double stall. Main slant driven in seam down full dip. Levels turned away right and left at intervals of about 70 yards. Double stalls 20 yards wide driven to full rise off levels. Pillars between double stalls 12 yards wide. Coal filled in face into low trams (carts) 2 feet 2 inches high over all. Stall roads self-acting inclines. Coal tipped into big trams (23 cwt.) standing on level. Carting and filling into trams done by boys, one boy to each stall road. Distance of haul up main slant about 1,000 yards.
Stock of Coal Tubs	250 large trams, and 300 small trams (carts).
Weight of Coal per tub	Large trams hold about 23 cwt. of coal, and small trams about 8 cwt.
Number of Coal-drawing Shafts	Day drift and hauling engine.
Depth	
Hours of Coal Drawing	10 hours daily, 7 A.M. to 5 P.M., for 8 days a fortnight 7 ,, 7 A.M. to 2 P.M., ,, 4 ,, 108 hours for 12 ,,

Labour Employed—

		Number.	Per cent.	Net Earnings. s. d.		s. d.
Below	Colliers	230	60	7 2		—
	Colliers' Boys	115	30	2 9	to	3 6
	Hauliers and Riders	25	7	5 7		—

The regular hours of work for all classes of labour are 54 per week, the same as the coal-drawing hours.

	Firemen - - - -		4	1 50 0 a week.
	Roadmen, &c. - -		8	2 6 -
		92 per cent.	382	100
Surface - -		8 ,,	33	
Total - - -		100 ,,	415	

		s. d.	s. d.	Per cent.	
Cost per ton -	Colliers Hewing - - -	2 4.5		59	
	Colliers' and Boys' Deadwork -	1 1.4	3 5.9	27	
	Other Labour Below - - - - - -		6.77	14	(Good roads, easily maintained.)
			4 0.67	100	
	Surface - - - - - - -		6.79		
			4 7.46		

Tons per Collier per Shift - -	2	tons.
Average Daily Output per hand employed below - - -	1.21	,,
Average Daily Output per hand employed below and surface -	1.116	,,

N.B.—In working this thin steep seam by double stall 90 per cent. of the labour (and 86 per cent. of the cost) is employed in and about the face.

No. VIII.—WARWICKSHIRE COLLIERY.

Output per fortnight	12,700 tons.
Number and Nature of Seams worked	Three seams, producing house and steam coal. Very little explosive used. Coal not hard.
Average Thickness of Coal	6 feet 3 inches (4,882 tons), 10 feet 6 inches (6,804 tons), 5 feet 2 inches (1,814 tons).
Gradient	1 in 3 to flat.
Method of Working	Longwall, with faces going both to the rise and to the dip. Stall roads 75 to 100 yards apart. Much crush on roads, costly to maintain. "Butty" system of labour. The stallmen (butties) engage and dismiss and pay the holers and getters. Stallmen's price, 1s. 10d. a ton (including per cent.) for getting and filling coal, tramming to top of "jig," timbering in face, and 15 yards outbye on stall roads, building all packs, shifting and laying way in face and 15 yards back on roads, and taking down top stone on roads over some distance for height of 4 feet 6 inches.
Stock of Coal Tubs	570.
Weight of Coal per tub	9½ cwts.
Number of Coal-drawing Shafts	One. 30 to 40 per cent. of the output is drawn at nights. "Round" coal loaded separately from the "slack" over 2 inch forks. Some "small" coal left below.
Depth	265 yards.
Hours of Coal Drawing	Day—10 hours, 6 A.M. to 4 P.M. Night—9 hours, 9 P.M. to 6 A.M. 40 minutes' stop for "bait." 18 hours 20 minutes daily. Sunday nights 8 hours, 10 P.M. to 6 A.M., 228 hours' coal-drawing per fortnight.

Labour Employed—

		Number.	Relative Proportion.	Net Earnings per Shift (including 45 per cent).		
			Per cent.	s. d.	s. d.	
Below	Stallmen	120	46	6 5	—	Usual length of shift for all hands, 9 to 9½ hours, with 40 minutes' stop for "bait."
	Holers and Getters	200		5 2	—	

	Repairers		128	18	5 2 —
	Trammers		108	15	4 0 to 5 2
	Deputies		12	2	6 5 —
	Various—Aircourses, Bondminders, &c.		132	19	3 0 to 5 2
		79 per cent.	700	100	
Surface		21 ,,	181		
Total		100 ,,	881		

		s. d.	Per cent	
Cost per ton	Stall Work	1 10	44	Costs taken on saleable tons (large and small), colliery consumption being deducted from drawings.
	Other Labour Below	2 3.6	56	
		4 1.6	100	
	Surface	0 5.0		
		4 6.6		

Tons per Hewer per Shift	3.3 tons.	Calculated on total output.
Average Daily Output per hand employed below	1.50 ,,	
Average Daily Output per hand employed below and surface	1.20 ,,	

No. IX.—STAFFORDSHIRE COLLIERY

Output per fortnight	11,914 tons per fortnight, working half-time owing to slack trade. 6.49 days = about 55 hours.
Number and Nature of Seams worked	Three ; one of them exceptionally hard.
Average Thickness of Coal	5 feet 9 inches (7,148 tons), 5 feet 10 inches (2,978 tons), 3 feet 6 inches (1,788 tons).
Gradient	Level to 1 in 3.
Method of Working	Longwall, with stall roads about 30 yards apart. Coal filled with rakes and pans, 10 to 25 per cent. being filled separately as "slack." Charter price varies from 1s. 8d. to 2s. 5d. (including per cent.) per ton on large coal sent out. This price covers coal-getting and loading, face timbering, building packs, shifting way in face, and delivering tub on stall road. Stallmen pay for their explosives. The company find all tools. Separate prices paid for filling "slack."
Stock of Coal Tubs	1,200.
Weight of Coal per tub	10 cwts.
Number of Coal-drawing Shafts	Four (3 downcast and 1 upcast), within a distance of about 2 miles.
Depth	375 yards ; 303 yards ; 300 yards (upcast) ; 127 yards.
Hours of Coal Drawing	8½ hours, 7.30 A.M. to 4 P.M., with half-hour's stop (11.30 to 12) for "snap."

Labour Employed—		Number	Per cent.	Net Earnings per Shift (including per cent.) s. d. s. d.	
Below	Stallmen	340	51	7 5 —	8½ hours bank to bank.
	Holers and Loaders (paid by Stallmen)	108		6 8 and 5 6	
	Datallers	95	11	5 0 to 4 4	

	Pony Drivers and Nippers	140	16	4 10 to 1 3	9½ hours.
	Deputies	15	2	6 8 —	
	Various	148	17	1 10 to 5 3	
	77 per cent.	872	100		
Surface	23 ,,	263			There are three separate screening and boiler plants. Surface labour includes also canal boat loading (23 men) and plate-laying (10 men).
Total	100 ,,	1,135			

		s. d.	Per cent	
Cost per ton	Stall Work	2 0.32	57	*N.B.*—These costs are taken on the saleable tons (large and slack), got by deducting the colliery consumption from the gross drawings.
	Other Labour Below	1 6.29	43	
		3 6.61	100	
		0 9.59		
		4 4.20		

Tons per Hewer per Shift	4.10 tons (includes Holers and Loaders with Stallmen).	
Average Daily Output per hand employed below	1.70 ,, over the whole year 1904.	Calculated on the total coal drawn.
Average Daily Output per hand employed below and surface	1.22 ,, ,, ,,	

No. X.—NOTTINGHAM HOUSE, STEAM, AND MANUFACTURING COAL COLLIERY.

Output per fortnight	31,780 tons.
Number and Nature of Seams worked	Four. The Top and Deep Hard, the Low Main and Deep Soft. Half of the output is derived from the Deep Soft.
Average Thickness of Coal	Top Hard, 4 feet 4 inches (645 tons); Deep Hard, 2 feet 11½ inches (6,064 tons); Low Main, 4 feet 6 inches (9,159 tons); Deep Soft, 3 feet 8¼ inches (15,912 tons).
Gradient	Moderate.
Method of Working	Longwall in each seam.
Stock of Coal Tubs	
Weight of Coal per tub (average)	10 cwts. in Top Hard, 9 cwts. in Deep Hard and Low Main, 9½ cwts. in Deep Soft.
Number of Coal-drawing Shafts	Five.
Depth ,, ,,	141, 356, 409, and two 384 yards.
Hours of Coal Drawing per day	9 hours, less 20 minutes for "snap," and 6 hours on Saturday.

Labour Employed—

		T. H.	D. H.	L. M.	D. S.
Below	Stallmen, Holers, Loaders	50 per cent.*	66 per cent.*	58 per cent.*	73 per cent.*
	Stonemen and Shifters		None.		
	Putter		None.		

	Hours per Shift		8 hours 40 minutes.		
		s. d.	s. d.	s. d.	s. d.
	Net Earnings per Shift	6 3.7	7 6.7	[illegible] 10.	7. 7.1
	Drivers and Boys of all Classes		2 0	to 3 6	
	Deputies, Firemen	6 8	6 8	6 8	6 8
	Remainder, Various (Datallers)		4 8	to 5 6	
	Hours of Labour		Same as above.		
	Total Underground Labour		1,042		1,029
Surface	Total Surface Labour		263		295
	Total		1,305		1,324
		s. d.	s. d.	s. d.	s. d.
ost per ton	*Total* Underground Labour	5 8.6	3 11	3 5.9	3 10.9
	Surface Labour	11.1	7.9	6.4	8.7
	Total Labour Cost	6 7.7	4 6.9	4 0.3	4 7.6
Tons per Collier per Shift			2.75	2.75	2.6
Average Daily Output per hand below and on surface	Below		1.2 tons.		1.35 tons.
	Surface		6.0 ,, (in time pit works)		6.15 ,,

* The numbers are the percentage of total labour.

No. XI.—YORKSHIRE HOUSE AND COKING COAL COLLIERY.

Output per fortnight	18,996 tons per fortnight of 10 days worked.
Number and Nature of Seams worked	Six. Of the usual character of the best house and coking coal seams of the Barnsley district.
Average Thickness of Coal—	

Seam.	Thickness.	Output.
Lidgett	2 feet 0 inches	1,332 tons.
Fenton	3 ,, 0 ,,	608 ,,
Parkgate	4 ,, 8 ,,	5,301 ,,
Thin Coal	2 ,, 6 ,,	3,894 ,,
Silkstone	4 ,, 2 ,,	3,156 ,,
Whinmoor	2 ,, 10 ,,	4,704 ,,

Gradient	1 in 12.
Method of Working	Longwall (with coal-cutting machines) for the Lidgett and Thin Coal Seams, and modified longwall in the other seams.
Stock of Coal Tubs	3,500.
Weight of Coal per tub	6½ cwts.
Number of Coal-drawing Shafts	Four.
Depth ,, ,,	146, 210, 211, and 91 yards respectively.
Hours of Coal Drawing per day per week	10.

Labour Employed—

		No.	Per cent. of Total.	Hours per Shift.	Net Earnings per Shift. s. d.
Underground	Hewers (Colliers)	605	43	8	6 11½
	Stonemen and Shifters	103	7	8	8 1
	Putters	316	23	8	5 9¼
	Drivers and Boys of all Classes	243	18	8	3 3½
	Deputies (Firemen)	18	1	8	7 3
	Remainder (Various)	109	8	8	5 10¼
		1,394	100		
Surface		500			
	Total	1,894			

			s. d.
Cost per ton for labour	*Underground*	(1) Hewing,	2 9½
		(2) Offhand,	1 8
	Total		4 5½
	Surface		0 9¾
	Total		5 3¼

Tons per Shift - - - - (Collier and Trammer) = tons "per set" per shift, 3½ tons.

Average Daily Output per hand employed	Below ground, 1.36 tons. Surface, - 3·79 "

Examples I. to XI. Compared.—Much information may b gathered from the foregoing examples. They cover most of th conditions under which coal is got in Great Britain,—namely, thi seams and thick seams (1 ft. 10 in. to 10 ft. 6 in.); deep and shallow (760 yards depth of shaft to seams cropping out at surface, an won by day drift); level and highly inclined (1 in 3 to flat); gass and dusty seams, where water spray jets are required along th main roads, to seams worked with naked lights; good roofs, wher the roads stand without timbering, to bad roofs where the stronges timbering requires constant renewal; seams worked on differen methods, longwall, bord and pillar, and double-stall; and wit various arrangements of labour: the two shifts of hewers system i the North of England, the collier system of South Wales and th Midlands, and the butty system of Warwickshire and Staffordshire

At Northumberland and Durham collieries, from 40 to 50 pe cent. of the hands employed underground, *i.e.*, rather less than hal are hewers. The length of their shift is about seven hours bank t bank daily, or per fortnight their hours of work full time run abou seventy-six.

The tons of coal they hew and fill per shift vary in the instance given from 2.84 to 4.84 tons, the average being 3.54 tons. Thes instances hardly cover the extreme limits, which may be put a about 2 tons in some of the thin, hard, steam coal seams to 5 and tons in some of the thick, soft coking and gas coal seams. Th 4 foot 9 inch seam working pillars in the No. II. instance must nc be taken as typical of the Northumberland steam coal collieries, th results in tons per hewer and cost of working being much bette than the average. But the average over the whole of Northumber land and Durham of 3½ tons is probably not far from the mark.

The *cost* of hewing at the North-country collieries constitute from 48 to 58 per cent., rather more than half of the total cost o underground labour. This proportion of cost varies generally a the tons got per hewer, which is reasonably to be expected. Th actual figures in the six instances vary from 1s. 3.26d. to 2s. 7.14d and give an average of 1s. 11d. a ton as the cost of hewing an filling the coal into tubs.

The average daily output per hand employed below is 1.48, sa 1½ tons, and 1.23, ¼ ton less, when the surface hands are taken int account also.

At the Welsh steam coal colliery the colliers form 35 per cen *i.e.*, about one-third instead of about one-half, of the total hand employed underground. They work 108 hours a fortnight (fu time) in place of the 76 hours of the North country hewer, and their earnings per shift are higher in about the same proportion as the longer time they work, allowing for the value of the free house and coal of the North country miner. But much of his time the Welsh collier is employed not in hewing but in stone work and timbering. About two-thirds of his wage is for hewing, and one-third for other work. In some of the thinner seams with a bad top stone, and little room for stowing it, this proportion is reversed, two-thirds of the colliers' time being employed on "dead" work, and only one-third on "coal" work. The best steam coal seams of South Wales, 5 feet and 6 feet thick, and full of "slips," require very little hewing, and are as different as possible in this respect from the hard steam coal seams of Northumberland.

Taking this into account, the production per man of the Welsh collieries is comparatively low, and the cost of hewing is high. This may be partly due to the use of the large tram holding 1 to 2 tons. A man will fill a 10-cwt. tub towards the end of his shift, where he would not attempt a 2-ton tram, and at many of the Welsh collieries the men restrict themselves to filling a certain number of trams, the limit being generally below what they might do.

The difficult natural conditions of many of the Welsh collieries, their depth, the heavy pressure on the roads, the precautions needed to prevent explosions of gas and dust, are apparent in the relatively high cost of off-hand labour or dead work, which forms 70 per cent. of the total underground cost, in comparison with 57 per cent. at the North country collieries. But these conditions by no means prevail throughout South Wales. The circumstances of the bituminous coal collieries and the anthracite collieries to the west of the coalfield, working shallow seams cropping out at the surface, are altogether different from those of the deep steam coal seams farther east. This is quite apparent from a comparison of examples No. VI. and No. VII. In No. VII., a bituminous coal colliery, working by day drift, a 2 foot 8 inch seam dipping inbye at a gradient of about 1 in 6 on the double-stall system, nearly all the work is done in the stalls; 60 per cent. of the men employed are colliers; and 59 per cent. of the underground cost is for hewing. The output per collier per shift is only 2 tons, and per hand below 1.21 ton, and the cost per ton of underground labour is 4s. 0.67d.

It is interesting to compare this with No. IV., a Durham gas coal colliery raising a similar quantity of coal of a similar quality, most of the output being "small" coal in both cases, and the hours of coal drawing per fortnight the same, 108. Here the production p hewer, working shorter hours, is 4.84 tons, and per hand employ below 1.92 ton, and the total underground cost on the saleab coal, 2s. 7.71d. The output is got from two seams instead of on and the workings are much more scattered and cover a wider are On the other hand, they are thicker seams, and lying generally lev instead of highly inclined.

But allowing for such differences, there can be no doubt th the results show a higher state of efficiency in the one case th the other.

At the Welsh colliery 382 hands are employed below, and 230 them (60 per cent.) are colliers, the most highly paid class of labo

At the Durham colliery 249 hands are employed for a simil output, and 97 of them (39 per cent.) are hewers. They wo shorter hours (76 per fortnight as compared with 108), but they g more than twice as much coal per man per shift. Most of the oth work, the dead work, is done by men who receive a lower wag To put the bulk of the work into the hands of the most highly pa men does not tend to economy of production.

Nos. VIII., IX., and X. are examples of longwall working on th butty system, where one man contracts to do all the work in a give length of face at a fixed price per ton of coal got, himself engagin and paying the other men needed. Strictly, it is the "little butty system which is in operation in these examples, where the butty the stallman, in contradistinction to the butty or contractor syste where a contractor undertakes the coal getting of a whole distric or it may be of the whole pit.

In No. IX. instance it is noticeable that the contractors or stal men do most of the work themselves, the holers and loade numbering only about one-fourth of the total employed in the fac This is due, no doubt, to the short time that the collieries a working, only six and a half days in the fortnight, which induces th stallmen to do more work, and to earn all they can for themselves

The effect of the short time is shown also in the high pro duction per man, 4.10 tons per collier, and 1.7 ton per ma employed below.

In No. VIII. instance there are, roughly, two holers and gette to each stallman.

The cost per ton of the stall work, which includes a good de more than getting and filling the coal, as stated, 1s. 10d. an 2s. 0.32d., corresponds closely with the cost of hewing at the Nort country collieries.

This comparison suggests that the butty system tends to economy.

In No. VIII. and No. IX. the proportion of men employed in the face—stallmen, holers, and getters—is also very similar to the proportion of hewers at Northumberland and Durham collieries; rather less than half the total engaged underground.

In the Potteries district, where the butty system is in general operation, the work of the holers and loaders is very irregular, as they "play" a good deal, owing to the fact that their wives and daughters and sisters work in the potteries. In this district it would be very difficult to work on the North country system of hewers. A system which may work very well in one district may be quite unsuitable for another, owing to different local circumstances.

The high cost of the off-hand labour in No. VIII. instance, 2s. 3.6d. higher than any of the others, with the one exception of the Welsh steam coal colliery, is explained partly by the unusual crush and pressure that exist on the main roads, making them very expensive to maintain. It is much the same at many of the Welsh collieries, and is a condition of things which adds seriously to the cost.

In No. VIII. example, coal-drawing is carried on during the night as well as the day, and the hours of coal-drawing per fortnight (228 hours) are twice as many as is usual. This also tends towards an increased cost of off-hand labour, as a good deal of the repairing work is done in the short interval of five hours between the day and night shift.

No. X. example, for which the authors are indebted to Mr Emerson Bainbridge, covers much the largest output and the most extensive scale of working, 31,780 tons a fortnight from four seams.

It will be noticed that no stonemen, shifters, or putters are employed, the greater part of the work that falls to these classes of labour in the Northern coalfield being here performed by the stallmen, or by others paid by the stallmen. The costs are low, with the exception of the top hard seam, from which only a very small output is obtained.

In No. XI. example, of a Yorkshire colliery, a noticeable point is the large proportion of putters employed, 23 per cent. of the total below; and the high wages they are paid, 5s. 9½d. a shift. Owing to the gradient of 1 in 12, and to the roof being generally bad, the putting is exceptionally difficult, and men rather than lads are needed for the work.

The low proportion of deputies or firemen in this and other instances—only 1 per cent. in comparison with 3 to 5 per cent. at Northumberland and Durham collieries—is due to the fact that at the latter the deputies do much of the timbering and laying way, which at the former is done by the colliers.

Size of Tub.—As regards the rolling stock, or number of tubs required, the large tubs which are customary in South Wales of course reduce the number needed for the same output.

Expressed in tons of output per fortnight, at the Welsh steam coal colliery, it is 25 tons per tub of 40 cwt., as compared with 5.4 tons per tub of 6½ cwt. at the Yorkshire colliery in No. XI. example, and 8 tons per tub of 8 cwt. at the Durham colliery in No. IV. example; or four and a half times as many tubs are required in No. XI. case as in No. IV. for the same output.

But when we reduce it to the "least common denominator" of "cwts. of coal held by the tub," the Welsh colliery comes out lower than any of the others, giving 0.625 ton of fortnightly output per tub per cwt. held as compared with 1 ton at the Durham colliery, and 0.834 ton at the Yorkshire colliery.

The increased use of the rolling stock, and consequently the fewer tubs required, where work goes on during the night as well as during the day, is shown by the results in No. VIII. example, where the output per fortnight is 22 tons per tub of 9½ cwt., or 2.31 tons per tub per cwt. it holds.

A good result is shown in No. II. example, where 7,250 tons are got from a 2 foot 7 inch seam with 350 tubs of 11½ cwt., equal to 20 tons per tub, or 1.74 ton per tub per cwt. Perhaps this size, 10 to 12 cwt., may be taken as the "golden mean."

As regards the relative cost and weight of the tubs, the 2 ton steel tram of the Welsh colliery, with Rowbotham wheels, costs £6. 9s. 6d., and weighs empty about 12 cwt., whereas the wooden tub of the Durham colliery costs £3. 2s. 6d., and weighs a little over 4 cwt. The stock of 750 trams, therefore, represents a capital expenditure of £4,856.

To provide a similar carrying capacity of 1,500 tons (*i.e.*, 750 trams of 2 tons each), 3,750 of the 8-cwt. tubs would be required, and 3,750 tubs at £3. 2s. 6d. each would cost £11,718.

The big tram is relatively much more economical in first cost, and also in cost of upkeep. It also adds considerably to efficiency in hauling and winding.

With two 2-ton trams, a single-decked cage brings up 4 tons of coal at a wind, and no movement of the cage is needed for changing trams. For a similar load with 10-cwt. tubs, eight of them would be required, and a cage with two or more decks, requiring more time for changing tubs, and adding much to the dead weight to be lifted.

As showing what can be done in hauling with the big tram, the following is an actual instance of horse haulage at a small Welsh colliery worked by day drift. The tram, in this instance, holds on an average 22½ cwt. of coal. It is made of wood, and weighs empty 6½ cwt.; it is fitted with Rowbotham wheels (well known for their efficient lubrication). The size of the wheels is 14 inches diameter, and most of the road is very wet. From the top of an engine bank the trams are conveyed by horses along a water level 350 yards in length, which brings them out to the day to the top of a self-acting incline leading to the screens. Two horses are employed, and one man and a boy; 8 to 9 trams go to each "set," or 9 to 10 tons of coal, and there are always two "sets" on the road, one following the other, the man going with the front set and the boy following In this way, 437 tons of coal, besides stone, have been led in ten hours, representing about twenty-five journeys each way, or a distance travelled by the horses of close upon ten miles.

The useful performance of each horse is therefore 220 tons of coal led 350 yards, or 44 tons of coal conveyed by each horse one mile per day—a very good result.

The labour is paid at a bargain price of ¾d. a ton (net), and this includes the conveyance of the coal down the self-acting incline to the screens, and the wages of another man employed at the bottom of the incline, besides the man and boy already mentioned.

General Summary.—If these examples of coal working (Nos. I.-XI., pp. 262-283) may be taken as fairly typical of British collieries, it appears that, at the rate of wages prevalent during the year 1904, the cost of labour on the average (omitting No. VI. example, where the cost is given on the large coal) was 3s. 11.3d., say 4s. a ton on labour employed underground, and 7.5d. on surface labour (screening, mechanics, etc.), making a total of 4s. 7d. This of course must be taken only as a rough average, to which there are many wide exceptions. It may be well to add that it is the cost of labour only, forming as a rule about 50 to 60 per cent. of the total cost of coal getting. To it has to be added the cost of materials, of royalty rent, of rates and taxes, and of management.

The average production of coal per hewer per shift runs about 3 tons. Per hand (man and boy) employed underground the average daily production is 1.39 tons, and including the surface hands 1.19 tons. In other words, under average conditions of British coal mining for a daily output of 1000 tons, 840 men and boys are required, 720 of them underground and 120 on the surface; of the 720 employed below, about 360 are hewers, receiving a wage of 6s. to 7s. a shift, and the other 360 are variously engaged at a lower wage, with the exception of some stonemen or repairers or rippers who are paid by the piece, and who earn high wages.

CHAPTER XVIII.

THE COLLIERY MANAGER AND THE LAW.

A SIGNIFICANT "Note" is prefixed to the Official Abstract of tl Coal Mines Regulation Act, which is issued by the Home Offi for posting up at collieries. It is in the following terms :—

> "NOTE.—This Abstract is intended mainly for the unde officials and workmen employed in the mine. *Owners, agents, an managers must learn their duties by studying the Act themselve* Among their duties not specified in this Abstract are those sending notice to the Inspector of the opening or abandonmen of any mine, shaft, or seam, of keeping accurate working plan of the mine, of sending to the Secretary of State accurate plans o the mine on its abandonment, of making annual returns, etc. etc."

In the sentence here italicised (it is not so distinguished in th official document) lies the gist of the Note, the duties subsequentl referred to being of a routine character, and such as may b undertaken by the parties concerned without sensibly increasin their burden of responsibility. But the owner, agent, or manage of a coal mine who studies the Act for himself will find that th legal maxim that "every man is presumed to know the law" ha a significance for him which will very appreciably increase hi responsibility so long as he fills the position he has assumed.

As in the case of other enactments imposing duties unde penalty, there may under certain circumstances be hardship o which he may not unreasonably complain; there may even b good ground for seeking not merely a change in the law, but radical amendment of its provisions in some respect or other; bu the law, when once duly enacted or established, has to be observe at one's peril, and it is the part of a wise man to seek to know an understand the *rationale* of the law he has to observe. It i unfortunate that the provisions of the law tend to become mor and more complex with the ever-varying conditions of human li and activity, while the demands upon time and attention in othe directions also increase; but still every man "must be presumed to know the law," if law is to maintain its hold on society.

Brief particulars of some of the Acts of Parliament with which (in addition to the Coal Mines Regulation Acts) the well-equipped colliery manager needs to make himself more or less familiar, and which the official "Note" so considerately reminds him he had better "study for himself," will be found towards the close of this chapter.

In several respects the legal position of the colliery manager, as compared with that of other professional men, is practically unique; and to adequately appreciate it, a brief survey of legislation in regard to collieries may be desirable.

Although in the case of other professions Parliament has made provision for the due qualification of persons setting up in the practice thereof, and although in the Factory Acts the Legislature has established numerous and elaborate provisions for the regulation, and ensuring the sanitary condition, of factories and workshops, and has prescribed the conditions under which children, young persons, and women may be employed therein, and has also made provision as to hours of work and holidays to be observed, yet in no other industry save mining—or, indeed (it may be said) coal-mining—has it been attempted by Act of Parliament to lay down precise rules and regulations for the conduct of the actual operations of a commercial undertaking.

The Principal Act is stated to apply to "mines of coal, mines of stratified ironstone, mines of shale, and mines of fire-clay" (sect. 3); but it is in coal-mining that the statutory rules and regulations are for the most part applicable, and these have been brought into operation by successive steps during the last sixty years, the first enactment of the Legislature having been the Mines and Collieries Act of 1842. By that enactment (which included a provision that "persons" in charge of engines were not to be under 15 years of age!) an inspector was appointed to visit and report upon collieries, but he was not invested with any power, even of suggestion, as to their working. The Coal Mines Inspection Act of 1850 provided for the appointment of additional inspectors, with power to enter upon underground workings of collieries, penalties being imposed in cases of obstruction of the inspector or refusal of information; and the Act also prescribed certain general rules to be observed at all collieries with a view to securing the safety of workings. Further Acts were passed in 1855, 1860, and 1862, by which time provision had been made (among other things) for the education of boys as a condition of their employment in mines, and the appointment of check-weighers by the working miners. But, as intimated in previous chapter (*ante*, p. 56), it was not until the passing of t Coal Mines Regulation Act of 1872 that the position of a collie manager was materially affected, and his work and responsibilit substantially increased by Act of Parliament. Provision h previously been made by the Act of 1862 for the adoption special rules applicable at each colliery in addition to the gener rules (15 in number) then made; and by the Act of 1872 these gene rules were increased to 31, and all persons taking the manageme of collieries were to be qualified by examination, in addition previous practical experience in the mine, as a condition of ranki as Certificated Colliery Managers. The Act of 1872, and a sho amending Act of 1886, were eventually superseded by the prese Principal Act of 1887. Since that date the main provisions of t law affecting the working of collieries have remained unaltered.

The present position of a colliery manager, with its extend duties and special responsibilities, is thus the creation, presumabl not of arbitrary measures, but of a process of legislative growth- Parliament from time to time enacting more stringent regulatio and extending the area of supervision; and whatever objecti may be taken to particular provisions of the law, the remarkab progress of the coal-mining industry during the six decades cover by this legislation, and the smooth working of the Acts throug the recurrent periods of prosperity and adversity which are s marked a characteristic of that industry, may be taken to sho that—in its main purpose, at all events—the course of legislatio has been on sound lines.

Further, Parliament has not only laid down general rules f the working of mines binding upon owners, managers, and work men alike, but has entrusted powers and duties in relation t such working to inspectors appointed by the Secretary of Stat As these provisions have an important bearing on the relation the colliery manager to the law, they may be set out here.

The duties of an inspector are to ascertain whether the Act i complied with in all mines within his jurisdiction; to ente inspect, and examine any mine, by day or night, at all reasonabl times, but so as not to impede or obstruct its working; to examin into and make inquiries respecting the state and condition of an mine, its ventilation, the sufficiency of its special rules, and every thing connected with or relating to the safety of the person employed in that or any contiguous mine, or the care and treat ment of the animals employed in the mine; and generally t exercise all other powers necessary for the effective carrying out of the Act.

If an inspector finds a mine or anything connected with it, or with the control, management, or direction thereof by the manager, to be dangerous or defective in any respect which is not provided against by the express provisions of the Act or some special rule, so as, in his opinion, to threaten or tend to the bodily injury of any person, he is to give notice in writing to either the owner, agent, or manager, setting forth the particulars in which he considers the mine to be dangerous or defective, and requiring the same to be remedied. Unless it be remedied forthwith, he is also to report the same to the Secretary of State.

If the owner, agent, or manager objects to comply with the notice, he may, within ten days after its receipt, send the grounds of his objection in writing to the Secretary of State, and have the matter determined by arbitration.

An owner, agent, or manager who fails, when no objection is sent, to comply with the requisition of the notice within ten days, or, when there has been an arbitration, to comply with the award within the time fixed by it, is to be guilty of an offence, of which the notice or award is to be deemed written notice. When proceedings are taken for this offence, the owner, agent, or manager may give evidence that he has taken active measures for complying with the notice or award, but has not been able to complete the works, though he has used reasonable diligence; and if the Court be satisfied that this is the case, it may postpone their decision on the question of inflicting a penalty, and if the works are completed within a reasonable time, no penalty is to be inflicted.

While the Act of 1887—the Principal Act—has greatly increased the legal responsibility of the manager (as also of the owner or agent) of a mine, yet in one important matter—that of daily supervision of the workings—it simplified if not lightened his duties by making a new provision on that subject. The previous Act of 1872 required that the mine should be "under the control and daily supervision" of the "manager"; and "it was clear from the true construction of that Act (said Lord Chief Justice Coleridge) that it was the duty of the manager to be in the mine day by day to supervise it; and when he undertook this most onerous duty, if he desired at any time to be away, then the Act required that he should provide some other certificated colliery manager to fill his place during the period of his absence" (judgment in *Plant* v. *Cheadle Valley Coal and Iron Company*,

[1882] Q.B.D.). The present Principal Act now provides (sect. 21 that in every mine daily personal supervision shall be exercised *either by* the manager *or by* an under-manager nominated in writing by the owner or agent, and holding either a first-class or a second-class certificate. Such under-manager "shall in the absence of the manager have the same responsibility and be subject to the same liabilities as the manager under this Act; but the nomination of an under-manager shall not affect the personal responsibility of the manager under this Act."

This is only one instance in which the Act, while in some respects extending the area of responsibility which is to fall ultimately on the manager responsible for the "control, management and direction" of the whole colliery, provides for that responsibility being delegated to (and to that extent shared by) a subordinate under-manager.

Perhaps the most notable provision of the law in force since 1887 is the following (sect. 50 of the Act):—

"Every person who contravenes or does not comply with any of the general rules in this Act shall be guilty of an offence against this Act; and in the event of any contravention of or non-compliance with any of the said general rules in the case of any mine to which this Act applies, by any person whomsoever, the owner, agent, and manager shall be guilty of an offence against this Act, unless he prove that he had taken all reasonable means, by publishing and to the best of his power enforcing, the said rules as regulations for the working of the mine, to prevent such contravention or non-compliance."

As already mentioned in a previous chapter (*ante*, p. 57), by this distinctive feature of the Act of 1887 the Legislature (in the words of the late Mr Maskell W. Peace) has thrown upon the colliery manager, "under various circumstances, a primary responsibility (which he can only rebut upon proof) should any person whomsoever contravene, or fail to comply with, its numerous stringent provisions."

The casual reader of the Principal Act might gather the impression that equal responsibility rests upon "owner," "agent," and "manager" alike; and in certain events this may conceivably happen to be the case. Thus the owner of a mine in which more than thirty persons are employed underground, or (as the case may be) the agent of such owner, cannot escape the initial requirement of the Act (sect. 20) that he "shall nominate himself or some other person to be manager of such mine," such manager to be duly qualified as a registered holder of a first-class certificate, nor the penalty of a fine not exceeding £50, and a further fine not exceeding £10 for every day during which a mine is worked for more than fourteen days without a duly qualified manager. Nor can the owner escape his ultimate liability for all such pecuniary outlay as may be required to ensure the proper working of his mine in accordance with the requirements of the law, although in this respect the onus lies on the manager to keep the owner fully apprised of his obligations, which can only be ascertained and realised by the application of the manager's professional skill and knowledge in working out the particular problems and solving the particular difficulties which present themselves in such variety in each separate colliery enterprise.

The Principal Act requires (sect. 49) that the "general rules [prescribed in the Act] shall be observed as far as it is reasonably practicable in every mine"; and it has been judicially decided that the expression "reasonably practicable" does not relate to the carrying on of the mine as a profitable concern, but to physical or engineering difficulties in the way of carrying out the rules (*Wales* v. *Thomas*, 16 Q.B.D. 340). It may readily happen, therefore, that there may not infrequently be a conflict between pecuniary interest on the part of an owner and the legal responsibility which will fall ultimately on the shoulders of the manager, should there be any default under the Act. Thus, as regards the all-important requirement (Rule 1) that "an adequate amount of ventilation shall be constantly produced in every mine to dilute and render harmless noxious gases," if upon complaint made it should be proved that the manager, by the means provided by the owner, might have improved the ventilation, he will be guilty of an offence under the Act (*Hall* v. *Hopwood*, 49 L.J.M.C. 17).

It is clear, therefore, that the substantial responsibility of compliance with the law, which means (in the event of failure or omission) liability to heavy penalties, rests in practice on the colliery manager.

Undoubtedly the *gravamen* of the complaint which (not unnaturally under the circumstances) is made by the colliery manager is that penal consequences (or in other words not merely civil but criminal liability) may attach to him, "unless he prove" his freedom from responsibility for the act or omission complained of; whereas it is an accepted rule in all criminal prosecutions that the burden of proof lies on the prosecutor, for "every man is presumed to be innocent until he is proved to be guilty."

This is not the place for an attempt to fully discuss either the propriety or the expediency of the law thus impeached, but one or two considerations may be suggested.

The general rule of evidence as to the burden of proof is, undoubtedly, that he who affirms must prove. "In civil actions it is sometimes a doubtful question where the burden of proof lies; but in criminal prosecutions the burden of proof is always on the side of the prosecutor in general, though as to particular items of the charge it may be on the prisoner. . . . . In particular instances, however, the burden of proof may be on the prisoner. For instance, many Acts of Parliament make it penal to do certain things, or even to possess certain articles (such as naval stores marked with the broad arrow), without lawful excuse or authority, *to be proved by the person in possession.*" *

An apology is perhaps necessary to the colliery manager for classing him, even temporarily and for sake of argument only, with presumably criminally-disposed classes of the community; but what is here said is sufficient to show that where from the nature of the case ascertainment of the truth in a legal proceeding is difficult without departure from an established rule of evidence, it is not unusual for such departure to be authorised.

Further, it may be remarked that the law, as regards diverse relations in life, does not profess so to parcel out the duties of a citizen as that he can escape responsibility so long as he himself is personally free from blame. "As in many cases acts and conduct that are morally blameworthy must go quit of anything the law can do, so in many cases, on the other hand, persons are exposed, for reasons of public expediency, to legal responsibilities which may or may not be associated with moral fault, and which cannot be avoided even by the fullest proof that in the particular case the person who is answerable before the law was morally blameless. . . . . Thus a man is liable in most civilised countries for the wrongful acts and defaults of his servants in the course of their employment, whatever pains he may have taken in choosing competent servants and giving them proper instructions. Obviously this is a hard rule for the employer in many cases, but its existence in every system of law shows that in the main it is felt to be just."†

A third consideration may be suggested from the point of view—not necessarily that of the lawyer, any more than the nining engineer (see *ante*, p. 58)—but one dear to the average Englishman, the point of view of practical utility? Has the provision f the Act of 1887, throwing upon the colliery manager the onus of roving, upon a mishap occurring, that he is *not* censurable, worked vell in practice? And looking to the complexity of the operations f a colliery, and the necessity of preserving fullest control by every esponsible official over matters within his province—coupled with he necessity of preventing friction between managerial responsiility on the one hand, and official watchfulness to observe that the egal standards of safe working are maintained, on the other—can ny better device be prescribed than requiring the official responsible or a particular course of action to be ready in any event to show hat he for his part has done everything required of him by the aw? And has the experience of eighteen years, since the imeached rule of evidence was established, shown that it works njustly—that the colliery manager is as a common experience njustly mulct in purse, or (more hatefully) oppressed in person?

---

* Sir J. Fitzjames Stephen, "General View of the Criminal Law" (1863), p. 303. See "Taylor on Evidence" for a list of many such statutes.

† Sir F. Pollock, "A First Book of Jurisprudence" (1896), pp. 50, 51.

Some such line of apology is probably the best that can be ffered for what the aggrieved colliery manager may still feel is a egitimate grievance.

There are, of course, large provinces of action and conduct in vhich the colliery manager, in the exercise of his calling, may ind himself under legal responsibility, irrespective of the provisions f the Mines Acts or other enactments concerning employers and vorkmen; but in this chapter we have not ventured to enter upon o large a field. As regards those particular enactments above—vhich the colliery manager, as a representative employer, is more r less directly concerned with—it must be admitted that the ollowing list is sufficiently substantial, if not formidable:—

The Coal Mines Regulation Acts, 1887 to 1905; the Truck Acts, 1831 to 1896; the Weights and Measures Acts, 1878 to 1897; the Fatal Accidents Acts, 1846 [Lord Campbell's Act], and 1864; the Employers' Liability Act, 1880; the Workmen's Compensation Acts, 1897 and 1900; the Explosives Act, 1875; the Trade Union Acts, 1871 and 1876; the Employers and Workmen Act, 1875; the Conspiracy and Protection of Property Act, 1875, and the Conciliation Act, 1896.*

---

* The provisions of these and of other enactments bearing on the adminisration of collieries will be found set out in "The Statutory Law relating to the Management and Rating of Collieries," by H. B. Hans Hamilton and Urquhart Forbes (1902), as also in the fuller text-books of Bainbridge, MacSwinney,

With regard to the Truck Acts, the colliery manager may do well to acquaint himself with their provisions as set out in an official Memorandum,* which has been issued by the Home Office for the use of His Majesty's Inspectors of Mines and Factories, and which significantly remarks at the outset that "the provisions of these Acts have given rise to considerable difficulty of interpretation, and it is to be expected that until they can be revised and consolidated some difficulty may arise with respect to them."

In general terms, the effect of the Truck Acts is to declare that the payment of workmen's wages *in goods* is illegal. Any workman or servant coming within the Acts is entitled to his wages *in money*, and the employer or master cannot set off the price of articles supplied as wages. Any employer, or agent to an employer, who infringes the Acts by paying or agreeing to pay wages *in goods*, is liable to a penalty of £10 for a first offence, £20 for a second offence, and £100 for a third (1 & 2 Wm. IV. c. 37). As stated in the Home Office Memorandum :—

> "The Acts apply to colliers, in addition to the clauses of the Mines Acts affecting check-weighing, but as a rule deductions under section 12 of the Coal Mines Regulation Act of 1887 are not really deductions from earned wages at all, but deductions from weights made in order to arrive at or compute wages, and hence such deductions will not offend against the Truck Acts, but their lawfulness or otherwise depends upon the Coal Mines Regulation Acts."

Again, according to the Memorandum :—

> "It is not only the mere employer of a workman who is liable to punishment for illegally paying a workman in goods or supplying goods to him, but also all masters, bailiffs, foremen, managers, clerks, and other persons employed in superintending his labour. Goods supplied to a workman by those persons in payment of his labour do not constitute a valid payment of his wages (Truck Act, 1831, section 25)."

The following clauses of the Memorandum relate to the supplementary Act of 1896 :—

> "Inasmuch as the older Truck Acts left untouched the power of the employer to inflict unlimited fines, or to make unlimited deductions in respect of bad work, or for materials to be used as a means of the workman's work, it was thought expedient to restrict and regulate this power, and, therefore, by the Truck Act of 1896, it was provided that such fines and deductions for negligent work, or materials supplied, should be prohibited except under stringent conditions.

---

and Cockburn. A smaller (but carefully compiled and annotated) volume is "The Miner's Guide," by L. A. Atherley-Jones, K.C., and Hugh H. L. Bellot ([illegible]), which is inscribed as "Dedicated to the Coal Miners of Great Britain."

* The full text of this Memorandum will be found in "Every Man's Own Lawyer" (43rd edition, 1906), which (in addition to the Truck Acts) also sets out the provisions of not a few of the enactments referred to in the text above.

"The provisions as to fines are as follows:—

"(1.) No money shall be deducted from wages or payment made by the workman, for or in respect of any fine, unless the terms are contained in a written contract signed by the workman, or else contained in a notice always kept in some place where it may be easily seen, read, and copied.

"It is to be observed here, that this section makes not only the deduction illegal, but the payment by the workman also illegal, and that the notice must be placed in a position in which it can be easily seen, read, and copied by every one affected by it. It is open to the employer to change the notice from time to time, but such change would only affect future employment, respecting which at the time of the notice there was no existing contract.

"(2.) The fines can only be fair and reasonable, and cannot be imposed except in respect of some acts reasonably likely to cause injury to the employer's business.

"(3.) At the time when any deduction or payment is made in respect of any fine, particulars of it must be supplied in writing, otherwise an offence against the Act has been committed.

"Deductions for bad or negligent work are under restrictions very similar to those imposed in the case of fines.

. . . .

"It is to be noted that—

"(1.) Not only is it an offence to make an illegal deduction, or receive an illegal payment, but also to make any contract for such deduction or payment. If, therefore, an employer posts a notice embodying excessive fines or other illegal deductions, and persons work under it, an offence will have been committed, although no illegal fine or other deduction may actually have been enforced.

"(2.) A limitation of time, six months for taking civil proceedings, is imposed by the Act, whereas in the other Truck Acts no such limit is fixed."

Another important provision of the law—not included in the Truck Acts—is the enactment by Parliament in 1883 (46 & 47 Vict. c. 31), that no wages shall be paid by any employer, or by any person on his behalf, to any workman at or within any public-house, beer-shop, or place for the sale of spirits, wines, beer, cider, or other spirituous or fermented liquor, or any office, garden, or place belonging thereto or occupied therewith (save the wages payable by the proprietor of any premises whereon such liquors are sold to any workman *bonâ fide* employed by him), under a penalty of £10 for each offence.

Under the Employers and Workmen Act, 1875 (38 & 39 Vict. c. 90), disputes between employers and workmen (not being domestic or menial servants) may be determined by Courts of Summary Jurisdiction,* where the amount claimed does not exceed

---

* Courts of Summary Jurisdiction consist, in country places, of two or more justices of the peace sitting in petty sessions, and in certain towns, of a stipendiary magistrate. The magistrates hear and decide cases *summarily*, without a jury.

£10; and by County Courts where the amount claimed does not exceed £50. The Court before whom such cases are brought may determine any contract between the parties on such terms as it thinks just; may adjust and set off, one against the other, claims made for wages, damages, or otherwise, on the part of either employer or workman; or, instead of giving damages for non-performance of a contract, may (at the option of the defendant, and with the consent of the plaintiff), arrange an undertaking by the defendant, and one or more sureties for the performance of the contract, subject on non-performance thereof to payment of a specified sum, not exceeding £10. Appeal from a decision of such a Court lies to Quarter Sessions, in manner provided by the Act.

By the Conciliation Act, 1896 (59 & 60 Vict. c. 30)—which superseded the previous enactment of 1872, known as the Arbitration (Masters and Workmen) Act—new powers were given to the Board of Trade for the settlement of trade disputes, but these are too restricted to be of any great effect.

Where a difference exists, the Board of Trade are authorised (i.) to inquire into the causes and circumstances of the difference; (ii.) to take steps for the purpose of enabling the parties to meet together; (iii.) on the application of employers or workmen interested, to appoint a person or persons to act as conciliator or as a board of conciliation; (iv.) on the application of both parties, to appoint an arbitrator.

The Act, however, is purely permissive; and as no compulsory powers are given either to the Board of Trade, or to a conciliator or an arbitrator, there are no means of giving actual effect to any decision which may be pronounced. (The case is very different where, in trade or other disputes, proceedings for their adjustment are taken under the Arbitration Act, 1889. There, a submission to arbitration, unless a contrary intention be expressed therein, is to be irrevocable, except by leave of the High Court or a Judge, and an award may be enforced in the same manner as a judgment or order of the Court.) Under the Conciliation Act, "the Board of Trade may act upon the submission of one of the parties, but since it has no power to enforce the award of the conciliator, this provision has never been invoked." *

In any proceedings in which a colliery manager may be interested, arising out of the Fatal Accidents Acts, or the Employers' Liability or Workmen's Compensation Acts, the application of the

---

* Atherley-Jones and Bellot in "The Miner's Guide."

Acts to any particular case will be so varied, and the manager's course will of necessity be so largely guided by professional legal advice, that it would hardly serve any useful purpose to discuss or even enumerate their provisions here. And a similar remark is applicable to the Trade Union Acts, and the other statute—the Conspiracy and Protection of Property Act—whose provisions have been of late years so widely discussed in relation to the action and obligations of trades unions. Moreover, the legal questions thus raised, in the light of recent decisions of the highest tribunals as to the scope and true interpretation of the Acts, are so subtle and (in a sense) so complicated, that it would be futile to attempt to consider them within the limits of the present chapter. And seeing that they are to form the subject of attempts at fresh legislation now (March 1906) about to be made in Parliament, both by the Government and by private members, one may well be content to await the course of events before resuming the subject. The Parliamentary session of 1906 cannot fail to be of abiding interest, for good or ill, to all who are interested in the procedure or welfare of trade unions.

APPENDIX

PAGE

I. Comparative Cost of Working Bord and Pillar and Modified Longwall at a Large Colliery - - 307

II. Coal Mines Regulation Act, 1887. Official Abstract of the Act, including the General Rules under the Act - - - - - - - 312

III. (a) Form of Special Rules established under the Act 332

(b) Special Rules for the Installation and Use of Electricity (issued by the Home Office, 1905) - 348

IV. Pitmen's Yearly Bonds (not now in use):—

Bond dated 23rd November 1767 - - - 360

Bond dated 20th November 1779 - - 362

Bond dated 19th March 1859 - - - 363

V. Forms of Hiring Agreements:—

First Form - - - - - - - 368

Second Form - - - - - - - 369

Third Form - - - - - - - 373

VI. Forms of Cavilling Rules:—

First Form - - - - - - - 377

Second Form - - - - - - - 379

Third Form - - - - - - - 382

VII. Joint-Committee Rules:—

Northumberland Steam Colliery Owners' and Miners' Joint-Committee - - - - - 384

Durham Coalowners' Association and Durham Miners' Association - - - - - 386

[illegible] Coal Mines Regulation Act, 1896. Text of the Act 392

[illegible]X. Mines (Prohibition of Child Labour Underground) Act, 1900. Text of the Act - - - - - 395

X. Coal Mines (Check Weigher) Act, 1894. Text of the Act - - - - - - - - 395

XI. Coal Mines (Weighing of Minerals) Act, 1905. Text of the Act - - - - - - - 396

XII. Explosives Order (Summary of its Provisions) - 399

APPENDIX.

I. COMPARATIVE COST

OF WORKING BORD AND PILLAR AND MODIFIED LONGWALL AT A LARGE COLLIERY.

I. COST OF WORKING IN THE WHOLE COAL BY BORD AND PILLAR METHOD (described in Chapter XI., page 187).—As shown in the annexed sketch (Fig. 119), the pillars are 66 × 33 yards from centre to centre. As the walls are driven 5 yards wide, no yard work is paid for them. The bords are 3 yards wide, and 8d. per yard is paid over and above the tonnage price. The roof is a very bad one, and it is exceedingly difficult to keep it supported with timber until the walls are holed. When a holing had been effected, it was found cheaper to draw out all the timber, and allow the roof to fall freely, and then drive another "fast place" on the rise side, leaving 6 feet of coal between it and the drawn out bord. This second "place" was driven 3 yards wide, and cost 1s. per yard for driving over and above the tonnage price.

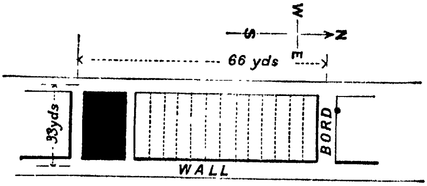


FIG. 119.—SKETCH ILLUSTRATING BORD AND PILLAR WORKING

The cost of working thus in the whole may be estimated as follows :—

Yards. Yards. Section.		
66 × 5 × 1.111	= 366	cubic yards.
33 × 3 × 1.111	= 110	"
30 × 2 × 1.111	= 67	"
Total cubic yards excavated in first working	543	"

Section of seam, 3 ft. 4 in. It is known that 1 cubic yard of coal from this seam weighs very nearly 18.83 cwts. Therefore $\frac{543 \times 18.83}{20} = 511.5$ tons is the yield of coal by the excavations made in the "whole" working. The cost per ton based on this yield is as follows, viz. :—

		Per Ton. s.	d.
Hewing—			
The score price is 14s. 4d. per score, or[*]		1	7.86
Consideration		0	0.32
Yard Work—			
For driving 30 yards, 3 yards wide, at 8d. per yard	£1 0 0		
For driving 30 yards, 2 yards wide, at 1s. per yard	1 10 0		
	£2 10 0		
£2 10 0 ÷ 511.5 =		0	1.17
Deputy Work—			
To find this cost, take 1.75 scores, which are the average scores got by the number of hewers under the charge of one deputy, per day in this pit ... 1.75=15.15 tons. Then 511.5 tons ÷ 15.15 = 33.76, the number of deputies' shifts occupied in driving these excavations ... ... 33.76 at 4s. 11d. = £8. 6s. ÷ 511.5 =		0	3.70
Cutting Bottom—			
66 + 33 + 30 = 129 yards at 1s. 4d. = £8. 12s. ÷ 511.5 =		0	4.03
Timber—			
The cost for timber was exceedingly high, the stone being so bad that a bord and wall had to be twice timbered during driving, and only one-third of the last timber was saved for further use. The amount for timber for driving a bord and wall was £25. 9s. 6d., which divided by 511.5 =		0	11.92
The cost for brattice doors and stoppings for bord and wall =2.83d. per ton, but it is found that this expenditure will ensure the ventilation of two pillars, therefore 2.83÷2 ... =		0	1.41
Cost of working in the whole		3	6.11

---

[*] The authors are indebted to Mr Thos. Lishman for permission to quote these figures.

II. Cost of Working Pillars.—This has been obtained by taking the quantities (money and scores) from the wage bills for six pays :—

	Per Ton. s.	d.
Paid for Hewing— £177. 9s. 3d. ÷ coals hewn 285 scores 9 tubs = 2472 tons =	1	5.23
Deputy Work— The amount for the same six pays was £35. 12s. 5d. ÷ 2472 ... =	0	3.45
Ridding, &c.— Ridders and chockmen drew all juds ... ... =	0	1.71
Bottom Cutting— Amount paid for six pays was £28. 5s. 6d. ÷ 2472 ... ... =	0	2.74
Timber— This is obtained by taking the total amount for the whole pit for same six pays, and the tons raised in the same time, viz., £333. 6s. 11d. ÷ 30,598 ... ... =	0	2.61
Cost of working in the broken	2	3.74

III. Cost of Working Modified Longwall.—The method here referred to has been described in Chapter XII., page 203, and the cost may be stated thus :—

	s.	d
Hewing— For same six pays as were taken for finding the cost of ordinary pillar working, there was paid £252. 2s. 9d. ; coal hewn in longwall in same time 429 score 3 tubs = 3717 tons; £252. 2s. 9d. ÷ 3717 ... ... =	1	4.28
Deputy Work— For same six pays, £35. 1s. 2d. ÷ 3717 ... ... =	0	2.26
Chockmen and Gatewaymen— £138. 19s. 4d. ÷ 3717 ... ... =	0	8.97
Bottom Cutters— £32. 17s. 7d. ÷ 3717 ... ... =	0	2.12
Timber and Chocks— This is obtained as in ordinary broken, and is taken at the same cost per ton, viz....	0	2.61
Cost of working longwall	2	8.24

Having found the cost of working in the whole and broken, and in the longwall, it is necessary to institute a comparison between these costs in order to arrive at a just conclusion. In doing this, the average costs of the whole and broken must be taken as the standard of comparison with longwall.

By calculation we found that a wall and two bords yielded 511.5 tons (see page 244). The yield of pillar when removed by Juds can be very nearly correctly estimated in the same way:—

Yds. Yds.* Yds.
66 − 8 = 58 length of pillar ... } Then, 58 × 28 × 1.111 sec. = 1804 cubic yards.
33 − 5 (wall) = 28 yards width of pillar }

$$1804 \times 18.83 = \frac{33969.32}{20} = 1698 \text{ tons}$$

Deducting loss in broken = 200 ,,

1498 ,,

Now 511.5 × 3s. 6.5d. = £90 11 6
And 1498.0 × 2s. 3¾d = 174 3 1

2009.5 £264 14 7

Then £264. 14s. 7d. ÷ 2009.5 = 2s. 7.61d., being the average cost of working by bord and pillar. Comparing this with cost of longwall, we have—

	Per Ton. s.	d.
Modified longwall	2	8.24
Bord and pillar	2	7.61
Difference in favour of bord and pillar working	0	0.63

But this result does not properly represent the relative advantages of the two systems of working in this pit, as it was found that the proportionate yield of round coal was higher by the longwall than by the bord and pillar method of working. From an elaborate series of trials the following results were arrived at:—

Longwall,	56.78	per cent. round;	43.22	per cent. of small coal.
Broken,	47.38	,, ,,	52.62	,, ,,
Whole,	46.67	,, ,,	53.33	,, ,,

This *increased produce of round coal is one of the chief advantages of the longwall mode of working*, and is best exhibited when compared with ordinary produce. Taking, say, 11s. 1d. per ton to be the average selling price of round coals over the pays enumerated above (taken to obtain cost of hewing) and of small, 3s. 5¾d. per ton:—

511.5 tons at 46½ per cent. of round ... ... = 237.84 tons.
1400.0 ,, 47¼ ,, ,, ... = 661.50 ,,

Total round yielded by whole and broken working of one pillar 899.34

---

* The actual deduction by calculation from figures already given is 7 yards, but 8 is perhaps nearer the truth, owing to liability to extra loss due to the extra bord.

511.5 – 237.84 … … = 273.66
1400.0 – 661.50 … … = 738.50

Total small yielded by the pillar 1012.16

Then 899.34 tons at 11s. 1d. =	£488	7	6
And 1012.16 " 3s. 5¾d. =	176	1	5
1911.50	£664	8	11

We thus arrive at £664. 8s. 11d. ÷ 1911.5 = 6s. 11.41d. per ton, being the average selling price of each ton of coals got by bord and pillar.

Treating the longwall mode of working in the same way, and using the above quantities, we have—

1911.5 tons at 56¾ per cent. of round produce = 1084.77 tons of round
1911.50 – 1084.77 = 826.73 tons of small

Then 1084.77 at 11s. 1d. =	£651	2	9
And 826.73 at 3s. 5¾d. =	143	14	7
	£794	17	4

£794. 17s. 4d. ÷ 1911.5 = 8s. 3.79d. per ton, being the average price per ton realised for coal worked by longwall, then 8s. 3.79d. – 6s. 11.41d. = 1s. 4.38d. (– 0.63d. extra cost of working), which means a balance o 1s. 3¾d. per ton in favour of the modified longwall, due entirely to th increased produce of round coal.

There is another advantage possessed by longwall which ought to b recognised. The hewers can produce more coals per shift than in bor and pillar, as the following results, taken on an average of six pays, show :—

Longwall hewers' produce	4.18 tons per shift.
Bord and pillar do. do.	3.16 " "
In favour of longwall	1.02 " "

This is equal to an increased production of 32¼ per cent. in favour o longwall.

II. COAL MINES REGULATION ACT, 1887

(50 & 51 VICT. C. 58).*

ABSTRACT OF THE ACT.†

1. *Inspection.*—The Secretary of State may appoint Inspectors (under whatever title he may from time to time fix) of mines, and assign them their duties.

For appointments to inspectorships in Wales and Monmouthshire, among candidates otherwise equally qualified, persons having a knowledge of the Welsh language shall be preferred. (S. 39.)

An Inspector may not himself be or practise, or be the partner of one who is or who practises, as land agent or mining engineer, or as a manager, viewer, agent, or valuer of mines, or as arbitrator in mining cases, and may not be otherwise employed in or about any mine, or be a miners' agent or a mine owner (whether such mine is one to which the Act applies or not), nor may he be a partner, or have any interest direct or indirect in any mine in the district under his charge. (S. 40.)

MANAGER AND UNDER-MANAGER.

2. *Manager.*—Every mine in which more than thirty persons are employed below ground, or, if less than thirty, where the Inspector by notice requires it, must be under the control, management, and direction of a manager, who may be the owner or agent or some other person holding a first-class certificate. Notice in writing of the name and address of a manager so appointed must be sent to the Inspector of the district. (S. 20.)

3. *Temporary appointment.*—If unable to obtain a certificated manager, the owner may appoint a competent person not certificated to be manager for not exceeding two months, or longer, until such person has an oppor-

---

* For amendments of this Act by subsequent Acts, see pages 392, 395, 396.

† The Abstract set out here is in the form issued by authority of the Secretary of State, for posting up at collieries, as required by s. 46 of the Act (see page 331). Amended Abstracts are issued from time to time, embodying the alterations made by later Acts.

tunity to obtain by examination a certificate in the district where he is acting. Notice to be sent to the Inspector. (S. 20 (*b*).)

4. *Daily personal supervision* of a mine must be exercised either by the manager or by an under-manager nominated in writing by the owner or agent of the mine. (S. 21 (1).)

5. *An under-manager* must hold either a first or second class certificate, and in the absence of the manager will have the same responsibility and be subject to the same liabilities as the manager; but the nomination of an under-manager will not affect the personal responsibility of the manager. (S. 21 (2).)

6. *Disqualification.*—A contractor for mineral, or person in the employ of such a contractor, is not eligible for the post of manager or under-manager under the Act. (S. 22.)

7. *Certificates.*—Holders of—

(1.) A certificate of competency under the Act of 1872, (2.) A certificate of service under the Act of 1872, (3.) A first-class certificate of competency under the Act of 1887,	Are qualified to be managers.

And holders of—

(1.) A second-class certificate of competency under the Act of 1887, (2.) A second-class certificate of service under the Act of 1887,	Are qualified to be under-managers.

Certificate of Service under the Coal Mines Act, 1887.—A second-class certificate of service under this Act shall be granted by the Secretary of State to every person that satisfies him either that before the 16th September 1887 he was exercising, and has since that date exercised, or that he has at any time within five years before the 16th September 1887 for a period of not less than twelve months exercised, in a mine required to have a manager, duties substantially corresponding to those of an under-manager of a mine. (S. 80.)

8. *Examinations.*—A board for examinations will be constituted for each district. The members are appointed by the Secretary of State; amongst them are three persons employed or who have been employed in or about a mine in the district not being owners, agents, or managers of a mine. Every applicant for a certificate of competency is examined by examiners appointed by the board according to rules made by the board as to the conduct of examinations and the qualifications of the applicants. (S. 24.) An applicant must first obtain an acknowledgment from the

Secretary of State that the requisite fee had been paid, which has been fixed to be for a first-class certificate £2, for a second-class £1. (S. 25 and Schedule II.)

No person shall be entitled to a certificate unless he has had practical experience in a mine for at least five years. (S. 23 (1).)

In every examination regard shall be had to such knowledge as is necessary for the practical working of mines in the district for which it is held. (S. 24 (2).)

In the case of applicants for second-class certificates the examination and qualifications required shall be suitable for practical working miners. (S. 24 (2).)

Every applicant who has passed the examination satisfactorily, and has given satisfactory evidence of sobriety, experience, ability, and general good conduct, is entitled to receive from the Secretary of State such a certificate of competency as his case requires. (S. 26 (1).)

ACCIDENTS.

9. *Accidents.*—Notice in writing shall be sent to the Inspector on behalf of the Secretary of State [in Scotland on behalf of the Lord Advocate], by the owner, agent, or manager of a mine, of the occurrence of any accident, whether above or below ground, which causes to any person employed in or about such mine loss of life, or serious personal injury, or if the accident is an explosion of gas or an explosion of explosive material, or explosion* of any steam boiler, any personal injury whatever, within twenty-four hours of such accident taking place, specifying in the notice the character of the explosion or accident, and the number of persons killed or injured respectively. (S. 35 (1).)

10. *Place of Accident.*—In the case of loss of life or serious personal injury in a mine, the place where the accident occurred shall be left as it was immediately after the accident for a period of three days, or until the visit of the place by an Inspector, unless so doing would tend to increase or continue danger, or would impede the working of the mine. (S. 35 (2).)

11. *Notice of Death.*—In the case of personal injury previously reported as directed by the Act, if the sufferer dies, notice of the death must be sent to the Inspector, within twenty-four hours after such death is known to the owner, agent, or manager. (S. 35 (3).)

12. *Inquiry into Accidents.*—A special inquiry into any explosion or accident in a mine, and of its causes and circumstances, may be held where the Secretary of State thinks such a formal investigation is expedient. (S. 45.)

---

* **NOTE.—Returns are to be made through the Board of Trade in the case of explosion of steam boilers.**

13. *Coroner's Inquest.*—The coroner, before opening an inquest on the body of a person whose death has been caused by an explosion or accident in or about a mine of which notice is required by the Act to be given to the Inspector, must not allow, nor must the constable summon for the purpose any person having a personal interest in, or employed in, or in the management of the mine to serve on the jury. (S. 48 (7).)

The coroner at the opening of the inquest may forthwith take evidence to identify the body and order the interment thereof. (S. 48 (3).)

The coroner may proceed with and conclude the inquest notwithstanding the absence of any Inspector, or other person, on behalf of the Secretary of State to watch the proceedings, if (*a*) he has given the Inspector twenty-four hours' notice of the time and place of holding the inquest; and (*b*) the explosion or accident has not caused the death of more than one person; and (*c*) the majority of the jury think it unnecessary to adjourn it. (S. 48 (4).)

In all other cases the coroner must, after opening the inquest, adjourn the inquiry to some later date, unless an Inspector or some person in behalf of the Secretary of State is present to watch the proceedings. (S. 48 (1).)

The coroner must give the Inspector of the district four days' notice in writing of the time and place of holding the adjourned inquest. (S. 48 (2).)

The coroner shall allow the Inspector present at the inquest to examine any witness, subject, however, to the order of the coroner.

The coroner shall also allow (*a*) any relative of any person whose death may have been caused by the explosion or accident; (*b*) the owner, agent, or manager of the mine; and (*c*) any person appointed by the order in writing of the majority of the workmen employed, to attend and examine witnesses at the inquest, either in person or by his counsel, solicitor, or agent, subject, however, to the order of the coroner. (S. 48 (8).)

The coroner, if it be an inquest at which an Inspector is not present, must send to the Inspector of the district notice in writing of any neglect or defect in or about a mine of which evidence has been given at the inquest as having caused or contributed to the explosion or accident, and which appears to the coroner or jury to require a remedy. (S. 48 (6).)

EMPLOYMENT OF BOYS, GIRLS, AND WOMEN.

14. "Boy" means a male under the age of sixteen.
"Girl" means a female under the age of sixteen.
"Woman" means a female of the age of sixteen or upwards. (S. 75.)

15. Misrepresentation of age is an offence. (S. 64.)

Restrictions as to Employment below Ground.

16. Girls and Women of any age Boys under 12	May not be employed.
Boys over 12	Not for more than fifty-four hours in one week. Not for more than ten hours in one day. Eight hours' interval between the period of employment on Friday and that of Saturday to be allowed. Twelve hours' interval between each other period of employment. A week to begin at midnight on Saturday and end at midnight on the succeeding Saturday. (Ss. 4, 5, 6).

17. The period of each employment shall be deemed to begin at the time of leaving the surface, and to end at the time of returning to the surface. (S. 6 (2).)

18. The immediate employer of every boy, if he is other than the owner, agent, or manager of the mine, shall, before he causes the boy to be below ground in any mine, report to the manager, or to some person appointed by the manager, that he is about to employ the boy in the mine. (S. 8 (2).)

Restrictions as to Employment above Ground.

19. Girls under 12 Boys under 12	May not be employed.
Girls under 13 Boys under 13	(*a.*) Not for more than six days in one week. (*b.*) Not for more than six hours a day if employed for more than three days in a week. (*c.*) Not for more than ten hours a day if employed for only three days or less than three days a week.
Boys of 13 and upwards Girls of 13 and upwards Women	Not for more than fifty-four hours in one week and ten hours in one day.

Boys
Girls
Women

(*a*.) Not to be employed between 9 P.M. and 5 A.M.
Not on Sunday.
Not after 2 P.M. on Saturday.

(*b*.) Eight hours' interval between the period of employment on Friday and that of Saturday to be allowed.
Twelve hours' interval between each other period of employment.

(*c*.) A week to begin at midnight on Saturday and to end at midnight on the succeeding Saturday.

(*d*.) If employed continuously for more than five hours, an interval of half an hour to be allowed for a meal.
If employed continuously for more than eight hours, an interval or intervals for meals, amounting to not less than an hour and a half, to be allowed.

(*e*.) Not to be employed in moving railway waggons. (Ss. 4, 5, 6.)

20. In the case of a mine in Ireland, if exempted by order of the Secretary of State, the employment of boys, girls, and women after 2 P.M. on Saturday is not prohibited. (S. 7, proviso.)

21. *School Fees.*—The person who pays the wages of a boy or girl must, after a single application in writing by the principal teacher of a public elementary school [in Scotland, State-aided school], which is attended by any boy or girl, pay regularly every week to such teacher, the cost of his or her schooling (not exceeding 2d. a week, or one-twelfth of the wages of the boy or girl), and may deduct from the wages of the boy or girl any sum so paid. (S. 10.)

22. *Sanitary Regulations.*—Where it appears to any local authority by the report of their surveyor, that persons of both sexes are employed or intended to be employed at one time in any portions of a mine which are above ground, the local authority may, if they think fit, by written notice, require the owner of the mine, within the time therein specified, to construct a sufficient number of water-closets, earth-closets, or privies and ashpits for the separate use of each sex. (S. 74.)

WAGES.

23. *Place of Payment.*—Wages are not to be paid on any premises used for the sale of intoxicating liquor, or in any place contiguous to such premises. (S. 11 (1).)

PAYMENT BY WEIGHT.

24. *Payment according to Weight.*—Where the amount of wages paid to any of the persons employed in a mine depends on the amount of mineral gotten by them, those persons shall be paid according to the actual weight gotten by them of the mineral contracted to be gotten, and the mineral gotten by them shall be truly weighed at a place as near to the pit mouth as is reasonably practicable. (S. 12 (1).)

25. *Deductions.*—The owner, agent, or manager may agree with the persons employed in the mine that reductions shall be made in respect of stones or substances other than the mineral contracted to be gotten, which shall be sent out of the mine with the mineral contracted to be gotten, or in respect of any tubs, baskets, or hutches being improperly filled, in those cases where they are filled by the getter of the mineral, or his drawer, or by a person immediately employed by him. (S. 12 (1).)

Such deductions may be determined in such special mode as may be agreed upon between the owner, agent or manager, or some person they may appoint on the one hand, and the persons employed in the mine and their check-weigher on the other; or, in the event of difference, by a third person, who is to be mutually agreed upon, or in default of agreement, tc be appointed by a chairman of quarter sessions within the jurisdiction o which any shaft of the mine is situate. (S. 12 (1).)

26. *Weighing Machines.*—The weighing apparatus used for determinin the wages payable according to the weight of the mineral gotten are subjec to the Weights and Measures Act, 1878-1889 (41 & 42 Vict. c. 49, anc 52 & 53 Vict. c. 21), and will be examined, once at least in every six months by an Inspector of weights and measures, or oftener if he suspects tha false weights or machines are being used. (S. 15.)

Such Inspector is also to inspect all measures and gauges in use at mine, whether used for determining wages or not, but nothing in this (15 section shall prevent or interfere with the use of the measures or gauge ordinarily used at the mine. (S. 15 (3).)

Such inspector in fulfilling his duties as aforesaid is not to impede o obstruct the ordinary working of the mine. (S. 15 (5).)

27.* *Check-weigher, his Appointment and Duties.*—The persons employe in any mine, who are paid according to the weight of mineral gotten b them, may station at their own cost a check-weigher at each place appointe for the weighing of the mineral or material, and at each place appointe for determining the deductions, in order that he may, on their behalf, tak a correct account of the weight of mineral or of the amount of deductions.

Such check-weigher is entitled to have every facility afforded him fo performing such duties, also for testing the weighing machines and checkin the tareing of tubs and trams where necessary. (S. 13 (1) and (2).)

The absence of a check-weigher is not to be any reason for interruptin or delaying the weighing or determination of the deductions and othe processes connected therewith, unless the check-weigher has had reasonable grounds to think the work in question would not be proceeded with (S. 13 (3).)

---

* For provisions of Acts of 1894 and 1905 relating to check-weighers, see pp. 395, 396.

28. *Information for Workmen.*—The check-weigher is authorised onl to take such account or determine such deductions as aforesaid; but h is at liberty to give to any workmen an account of the mineral gotten b him, or information with respect to the weighing or weighing machine, th tareing of the tubs or trams, the determination of the deductions, or an matter within the scope of his duties as a check-weigher. (S. 13 (3).)

29. *Non-interference with Working.*—A check-weigher may not in an way impede or interrupt the working of the mine, or interfere with th weighing, or with any of the workmen, or with the management of th mine. (S. 13 (3).)

30. *Excess of Duty.*—If a check-weigher can be proved to have impeded or interrupted the working of the mine, or interfered with the weighin or with any of the workmen, or at the mine, to the detriment of the owner agent, or manager, done anything beyond taking such account, determinin such deductions, or giving such information as aforesaid, he is liable t be summoned on the complaint of the owner, agent, or manager before a court of summary jurisdiction, and the court may, if it thinks fit, afte hearing the parties, make summary order for his removal. (S. 13 (4).)

Another check-weigher may be appointed in his stead. (Ss. 13 (5) and 61 (2).)

31. *Remuneration.*—Where a check-weigher has been appointed by the majority, ascertained by ballot, of the persons employed in a mine, and paid by weight of mineral gotten by them, and has acted as such, he may recover from any person for the time being employed in such mine, such proportion of his wages as may be due from such person, notwithstanding that any of the persons by whom the check-weigher was appointed may have subsequently left, and others have entered the mine.

And the owner or manager where the majority determined by ballot so agree, may retain for the check-weigher the agreed contribution from the wages of the persons so employed, and account for the same to the check-weigher. (S. 14 (1).)

32. *Check-measurer.*—At a mine where, by permission of the Secretary of State, the persons employed are paid by measure or gauge of the mineral gotten by them, a check-measurer may be appointed whose rights and duties correspond to those of the check-weigher. (S. 13 (7).)

SHAFTS.

33. *Two to a Mine.*—Subject to special exceptions, every mine must have two shafts or outlets in communication with every seam at work, and

capable of affording separate means of ingress and egress to the persons employed in every such seam. (S. 16 (1).)

34. *Distance Apart.*—The shafts shall not at any point be nearer to one another than 15 yards, except in the case of a mine provided before the 1st January 1865 with two shafts less than 10 feet apart, and in that of a mine provided before the 1st January 1888 with two shafts more than 10 feet but less than 15 yards apart. (S. 18 (3).)

35. *Communications between Shafts.*—Communications between the shafts or outlets must be made not less than 4 feet wide and 4 feet high.

Exceptions.—(*a.*) In case the communications were made before the 1st January 1888 of the dimensions of 4 feet wide, and though less than 4 feet, not less than 3 feet high, they may be continued in use without enlargement. (S. 16 (1) (*b*).)

(*b.*) The communications between shafts and outlets in any mine or class of mines are not required to be of the dimensions prescribed in the Act if exempted by order of the Secretary of State—

(*a.*) In the case of the thinness of the seams:

(*b.*) Or in the case of other exigencies affecting such mine or class of mines.

Provided in either case that the conditions (if any) annexed to the order of exemption are duly observed. (S. 18 (iii.).)

36. *Machinery for Travelling Up and Down.*—Proper apparatus for raising and lowering persons at each such shaft or outlet shall be kept on the works belonging to the mine; and such apparatus, if not in actual use at the shafts or outlets, shall be constantly available for use. (S. 16 (1) (*c*).)

See par. 58 (G. R. S.) as to examination of shafts, and pars. 76, 77 (G. R. 19, 20) as to fencing shafts.

GENERAL RULES.

37. The following are the General Rules which are to be observed so far as is reasonably practicable in every mine. (S. 49)* :—

[The reports which, under the General Rules, are to be recorded in books are:—*Rule* 1. Monthly, as to ventilation, excepting at mines not required to have a certificated manager. *Rule* 4. State of mine, daily, and for shifts having an interval between; to be in the handwriting of the person who makes the inspection. *Rule* 5. Machinery, guides, conductors, daily; shafts, weekly; each to be signed by the person who makes the inspection. *Rule* 7. Withdrawal in case of danger. (G. R. 37.)]

Rule 1. *Ventilation.*—An adequate amount of ventilation shall be constantly produced in every mine to dilute and render harmless noxious gases to such an extent that the working places of the shafts, levels, stables, and workings of the mine, and the travelling roads to and from those working places shall be in a fit state for working and passing therein,

---

* For provisions of the Coal Mines Regulation Act, 1896, as to this section, see pp. 392, 394.

In the case of mines required by this Act to be under the control of a certificated manager, the quantity of air in the respective splits or currents shall, at least once in every month, be measured and entered in a book to be kept for the purpose at the mine.

Rule 2. Where a fire is used for ventilation in any mine newly opened after the passing of this Act, the return air, unless it be so diluted as not to be inflammable, shall be carried off clear of the fire by means of a dumb drift or airway.

Rule 3. Where a mechanical contrivance for ventilation is introduced into any mine after the commencement of this Act, it shall be in such position, and placed under such conditions, as will tend to ensure its being uninjured by an explosion.

Rule 4. *Examination of Mine.* (*a.*) *Before each Shift commences Work.*—A station or stations shall be appointed at the entrance to the mine, or to different parts of the mine, as the case may require; and the following provisions shall have effect:—

(i.)* As to inspection before commencing work:—

A competent person or competent persons appointed by the owner, agent, or manager for the purpose, not being contractors for getting minerals in the mine, shall, within such time immediately before the commencement of each shift as shall be fixed by special rules made under this Act, inspect every part of the mine situate beyond the station or each of the stations, and in which workmen are to work or pass during that shift, and shall ascertain the condition thereof so far as the presence of gas, ventilation, roof and sides, and general safety are concerned.

No workman shall pass beyond any such station until the part of the mine beyond that station has been so examined and stated by such competent person to be safe.

The inspection shall be made with a locked safety-lamp, except in the case of any mine in which inflammable gas has not been found within the preceding twelve months.

A report specifying where noxious or inflammable gas, if any, was found present, and what defects (if any) in roofs or sides, and what (if any) other source of danger were or was observed, shall be recorded without delay in a book to be kept at the mine for the purpose, and accessible to the workmen, and such report shall be signed by, and so far as the same does not consist of printed matter, shall be in the handwriting of the person who made the inspection.

For the purpose of the foregoing provisions of this rule, two or more shifts succeeding one another without any interval are to be deemed to be one shift. [See also "Shot-firing," par. 67.]

(*b.*) *During Working Shift.*—(ii.) As to inspection during shifts:—

---

* See section 5 of Coal Mines Regulation Act, 1896, at page 394.

A similar inspection shall be made in the course of each shift of all parts of the mine in which workmen are to work or pass during that shift, but it shall not be necessary to record a report of the same in a book: Provided that in the case of a mine worked continuously throughout the twenty-four hours by a succession of shifts, the report of one of such inspections shall be recorded in manner above required.

Rule 5. *Machinery.*—A competent person or competent persons appointed by the owner, agent, or manager for the purpose, shall, once at least in every twenty-four hours, examine the state of the external parts of the machinery, the state of the guides and conductors in the shafts, and the state of the head gear, ropes, chains, and other similar appliances of the mine which are in actual use both above ground and below ground, and shall once at least in every week examine the state of the shafts by which persons ascend or descend; and shall make a true report of the result of such examination, and every such report shall be recorded without delay in a book to be kept at the mine for the purpose, and shall be signed by the person who made the inspection.

Rule 6. *Fencing.*—Every entrance to any place which is not in actual use or course of working and extension shall be properly fenced across the whole width of the entrance, so as to prevent persons inadvertently entering the same.

Rule 7. *Dangerous Places.*—If at any time it is found by the person for the time being in charge of the mine, or any part thereof, that by reason of inflammable gases prevailing in the mine, or that part thereof, or of any cause whatever, the mine or that part is dangerous, every workman shall be withdrawn from the mine or part so found dangerous, and a competent person appointed for the purpose shall inspect the mine or part so found dangerous, and if the danger arises from inflammable gas, shall inspect the mine or part with a locked safety-lamp; and in every case shall make a true report of the condition of the mine or part; and a workman shall not, except in so far as is necessary for inquiring into the cause of danger or for the removal thereof, or for exploration, be re-admitted into the mine, or part so found dangerous, until the same is stated by the person appointed as aforesaid not to be dangerous. Every such report shall be recorded in a book which shall be kept at the mine for the purpose, and shall be signed by the person who made the inspection.

Rule 8. *Naked Lights.*—No lamp or light other than a locked safety-lamp shall be allowed or used—

(*a.*) In any place in a mine in which there is likely to be any such quantity of inflammable gas as to render the use of naked lights dangerous; or

(*b.*) In any working approaching near a place in which there is likely to be an accumulation of inflammable gas.

And when it is necessary to work the coal in any part of a ventilating district with safety-lamps, it shall not be allowable to work the coal with naked lights in another part of the same ventilating district situated between the place where such lamps are being used and the return airway.

Rule 9. **Safety-lamps.*—Wherever safety-lamps are used, they shall be so constructed that they may be safely carried against the air-current ordinarily prevailing in that part of the mine in which the lamps are for the time being in use, even though such current should be inflammable.

Rule 10. *Locking Lamps.*—In any mine or part of a mine in which safety-lamps are required by this Act, or by the Special Rules made in pursuance of this Act, to be used—

(i.) A competent person appointed by the owner, agent, or manager for the purpose, shall, either at the surface or at the appointed lamp station, examine every safety lamp immediately before it is taken into the workings for use, and ascertain it to be in safe working order and securely locked; and such lamps shall not be used until they have been so examined and found in safe working order, and securely locked:

(ii.) A safety-lamp shall not be unlocked except either at the appointed lamp station, or for the purpose of firing a shot, in conformity with the provisions hereinafter contained:

(iii.) A person, unless he has been appointed either for the purpose of examining safety-lamps, or for the purpose of firing shots, shall not have in his possession any contrivance for opening the lock of any safety-lamp:

(iv.) *Lucifers.*—A person shall not have in his possession any lucifer match or apparatus of any kind for striking a light, except within a completely closed chamber attached to the fuse of the shot.

Rule 11. *Lamp Station.*—Where safety-lamps are required to be used, the position of the lamp stations for lighting or relighting the lamps shall not be in the return air.

Rule 12. **Shot-firing.*—Any explosive substance shall only be used in the mine below ground as follows:—

(*a.*) It shall not be stored in the mine:

(*b.*) It shall not be taken into the mine, except in cartridges in a secure case or canister, containing not more than 5 lbs.:

> Provided that on the application of the owner, agent, or manager of any mine, the Secretary of State may by order exempt such mine from so much of this rule as forbids taking an explosive substance into the mine except in cartridges:

(*c.*) A workman shall not have in use at one time in any one place, more than one of such cases or canisters:

---

* See section 5 of Coal Mines Regulation Act, 1896, at page 394

(*d.*) In the process of charging or stemming for blasting, a person shall not use or have in his possession any iron or steel pricker, scraper, charger, tamping rod or stemmer, nor shall coal or coal dust be used for tamping:

(*e.*) No explosive shall be forcibly pressed into a hole of insufficient size, and, when a hole has been charged, the explosive shall not be unrammed, and no hole shall be bored for a charge at a distance of less than 6 inches from any hole where the charge has missed fire:

(*f.*) In any place in which the use of a locked safety-lamp is for the time being required by or in pursuance of this Act, or which is dry and dusty, no shot shall be fired except by or under the direction of a competent person appointed by the owner, agent, or manager of the mine, and such person shall not fire the shot or allow it to be fired until he has examined both the place itself where the shot is to be fired, and all contiguous accessible places of the same seam within a radius of 20 yards, and has found such place safe for firing:

(*g.*) If in any mine, at either of the four inspections, under Rule 4 recorded last, before a shot is to be fired, inflammable gas has been reported to be present in the ventilating district in which the shot is to be fired, the shot shall not be fired—

(1.) Unless a competent person, appointed as aforesaid, has examined the place where gas has been so reported to be present, and has found that such gas has been cleared away, and that there is not at or near such place sufficient gas issuing or accumulated to render it unsafe to fire the shot; or

(2.) Unless the explosive employed in firing the shot is so used with water or other contrivance as to prevent it from inflaming gas, or is of such a nature that it cannot inflame gas:

(*h.*) If the place where a shot is to be fired is dry and dusty, then the shot shall not be fired unless one of the following conditions is observed, that is to say,—

(1.) Unless the place of firing, and all contiguous accessible places within a radius of 20 yards therefrom, are at the time of firing in a wet state from thorough watering or other treatment equivalent to watering, in all parts where dust is lodged, whether roof, floor, or sides; or

(2.) In the case of places in which watering would injure the roof or floor, unless the explosive is so used with water or other contrivance as to prevent it from inflaming gas or dust, or is of such a nature that it cannot inflame gas or dust:

(*i.*) If such dry and dusty place is part of a main haulage road, or is a place contiguous thereto, and showing dust adhering to the roof and sides, no shot shall be fired there unless—

(1.) Both the conditions mentioned in sub-head (*h*) have been observed; or

(2.) Unless such one of the conditions mentioned in sub-head (*h* as may be applicable to the particular place has been observed and moreover all workmen have been removed from the seam in which the shot is to be fired, and from all seams communicating with the shaft on the same level, except the men engaged in firing the shot, and such other persons, not exceeding ten, as are necessarily employed in attending to the ventilating furnaces, steam boilers, engines, machinery, winding apparatus, signals, or horses, or in inspecting the mine:

(*k*) In this Act "ventilating district" means such part of a seam as has an independent intake commencing from a main intake air-course, and an independent return airway terminating at a main return air course; and "main haulage road" means a road which has been, or for the time being is, in use for moving trams by steam or other mechanical power:

(*l*.) Where a seam of a mine is not divided into separate ventilating districts, the provisions in this Act relating to ventilating districts shall be read as though the word "seam" were substituted for the words "ventilating district":

Clay and Ironstone Mines.—(*m*.) So much of this rule as requires the explosive substance taken into the mine to be in cartridges, and so much of the provisions of sub-head (*f*) as relates to a dry and dusty place, and the provisions (*g*), (*h*), (*i*), (*k*), and (*l*) shall not apply to seams of clay or stratified ironstone which are not worked in connection with any coal seam, and which contain no coal in the working.

Rule 13. *Water.*—Where a place is likely to contain a dangerous accumulation of water, the working approaching that place shall not at any point within 40 yards of that place exceed 8 feet in width, and there shall be constantly kept at a sufficient distance, not being less than 5 yards in advance, at least one bore-hole near the centre of the working, and sufficient flank bore-holes on each side.

Rule 14. *Refuges on Underground Planes worked by Machinery.*—Every underground plane on which persons travel, which is self-acting or worked by an engine, windlass, or gin, shall be provided (if exceeding 30 yards in length) with some proper means of communicating distinct and definite signals between the stopping places and the ends of the plane, and shall be provided in every case with sufficient manholes for places of refuge, at intervals of not more than 20 yards, or if there is not room for a person to stand between the side of a tub and the side of the plane, then (unless the tubs are moved by an endless chain or rope) at intervals of not more than 10 yards.

Rule 15. *Refuges on Horse Roads.*—Every road on which persons travel underground, where the load is drawn by a horse or other animal, shall be provided, at intervals of not more than 50 yards, with sufficient manholes, or with places of refuge, and every such place of refuge shall be of sufficient length, and at least 3 feet in width, between the waggons running on the road and the side of such road. There shall be at least two proper travelling ways into every steam-engine room and boiler gallery.

Rule 16. *Refuge to be kept clear.*—Every manhole and every place of refuge shall be constantly kept clear, and no person shall place anything in any such manhole or place of refuge.

Rule 17. *Horse Roads: Height to clear Horse.*—Every travelling road on which a horse or other draught animal is used underground shall be of sufficient dimensions to allow the horse or other animal to pass without rubbing against the roof or timbering.

Rule 18. *Fencing: Shafts not in use.*—The top of every shaft which for the time being is out of use, or used only as an air shaft, shall be and shall be kept securely fenced.

Rule 19. *Shafts in use.*—The top and all entrances between the top and bottom, including the sump, if any, of every working, ventilating, or pumping shaft shall be properly fenced, but this shall not be taken to forbid the temporary removal of the fence for the purpose of repairs or other operations, if proper precautions are used.

Rule 20. *Shaft to be Cased.*—Where the natural strata are not safe, every working or pumping shaft shall be securely cased, lined, or otherwise made secure.

Rule 21. *Security of Roofs and Sides.*—The roof and sides of every travelling road and working place shall be made secure, and a person shall not, unless appointed for the purpose of exploring or repairing, travel or work in any such travelling road or working place which is not so made secure.

Rule 22. *Propping Timber.*—Where the timbering of the working places is done by the workmen employed therein, suitable timber shall be provided at the working place, gate end, pass bye, siding or other similar place in the mine, convenient to the workmen, and the distance between the sprags or holing props where they are required shall not exceed 6 feet, or such less distance as may be ordered by the owner, agent, or manager.

Rule 23. *Use of Downcast Shaft.*—Where there is a downcast and furnace shaft to the same seam, and both such shafts are provided with apparatus in use for raising and lowering persons, every person employed in the mine shall, on giving reasonable notice, have the option of using the downcast shaft.

Rule 24. *Competency of Engineers.*—In any mine which is usual entered by means of machinery, a competent male person not less th twenty-two years of age shall be appointed for the purpose of working t machinery which is employed in lowering and raising persons therein, a shall attend for that purpose during the whole time that any person below ground in the mine.

Where any shaft, plane, or level is used for the purpose of communic tion from one part to another part of a mine, and persons are taken up down or along such shaft, plane, or level by means of any engine, windla or gin, driven or worked by steam or any mechanical power, or by animal, or by manual labour, the person in charge of such engine, windla or gin, or of any part of the machinery, ropes, chains, or tackle connect therewith, must be a competent male person not less than eighteen yea of age.

Where the machinery is worked by an animal, the person under who direction the driver of the animal acts, shall for the purposes of this ru be deemed to be the person in charge of the machinery.

Rule 25. *Signalling.*—Every working shaft used for the purpose drawing minerals, or for the lowering or raising of persons, shall, if excee ing 50 yards in depth, and not exempted in writing by the Inspector the district, be provided with guides and some proper means of co municating distinct and definite signals from the bottom of the shaft a from every entrance for the time being in use between the surface and t bottom of the shaft to the surface, and from the surface to the bottom the shaft, and to every entrance for the time being in use between t surface and the bottom of the shaft.

Rule 26. *Overwinding.*—If in any mine the winding apparatus is n provided with some automatic contrivance to prevent overwinding, th the cage, when men are being raised, shall not be wound up at a spe exceeding 3 miles an hour, after the cage has reached a point in t shaft to be fixed by the Special Rules.

Rule 27. *Cover for Cage.*—A sufficient cover overhead shall be us for every cage or tub employed in lowering or raising persons in a working shaft, except where the cage or tub is worked by a windlass, where persons are employed at work in the shaft, or where a writt exemption is given by the Inspector of the district.

Rule 28. *Chain.*—A single linked chain shall not be used for loweri or raising persons in any working shaft or plane, except for the sh coupling chain attached to the cage or tub.

Rule 29. *Winding Drum.*—There shall be on the drum of eve machine used for lowering or raising persons, such flanges or horns, a also if the drum is conical, such other appliances as may be sufficient prevent the rope from slipping.

Rule 30. *Winding Brakes: Position of Cage.*—There shall be attached to every machine worked by steam, water, or mechanical power, and used for lowering or raising persons, an adequate brake or brakes, and a proper indicator (in addition to any mark on the rope) showing to the person who works the machine the position of the cage or tub in the shaft.

If the drum is not on the crank shaft, there shall be an adequate brake on the drum shaft.

Rule 31. *Fencing Machinery.*—Every fly-wheel and all exposed and dangerous parts of the machinery used in or about the mine shall be and shall be kept securely fenced.

Rule 32. *Steam Boiler.*—Each steam boiler, whether separate or one of a range, shall have attached to it a proper safety-valve, and also a proper steam gauge and water gauge, to show respectively the pressure of steam and the height of water in each boiler.

Rule 33. *Atmospheric Pressure and Temperature.*—A barometer and thermometer shall be placed above ground in a conspicuous position near the entrance to the mine.

Rule 34. *Ambulances.*—Where persons are employed underground, ambulances or stretchers, with splints and bandages, shall be kept at the mine ready for immediate use in case of accident.

Rule 35. *Safety Contrivances.*—No person shall wilfully damage, or without proper authority remove or render useless, any fence, fencing, manhole, place of refuge, casing, lining, guide, means of signalling, signal, cover, chain, flange, horn, break, indicator, steam gauge, water gauge, safety valve, or other appliance or thing provided in any mine in compliance with this Act.

Rule 36. *Obedience to Orders.*—Every person shall observe such directions with respect to working as may be given to him with a view to comply with this Act or the Special Rules in force in the mine.

Rule 37. *Books.*—The books mentioned in these Rules shall be provided by the owner, agent, or manager, and the books, or a correct copy thereof, shall be kept at the office at the mine, and any Inspector under this Act, and any person employed in the mine, or any one having the written authority of any Inspector or person so employed, may at all reasonable times inspect and take copies of and extracts from any such books; but nothing in these Rules shall be construed to impose the obligation of keeping any such book or a copy thereof for more than twelve months after the book has ceased to be used for entries therein under this Act. (See par. 52.)

Any report by this Act required to be recorded in a book may be partly in print (including lithograph) and partly in writing.

Rule 38. *Inspection on behalf of Workmen.*—The persons employed in a mine may from time to time appoint two of their number or any two persons, not being mining engineers, who are practical working miners, to inspect the mine at their own cost, and the persons so appointed shall be allowed once at least in every month, accompanied, if the owner, agent, or manager of the mine thinks fit, by himself or one or more officers of the mine, to go to every part of the mine, and to inspect the shafts, levels, planes, working places, return airways, ventilating apparatus, old workings, and machinery. Every facility shall be afforded by the owner, agent, and manager, and all persons in the mine for the purpose of the inspection, and the persons appointed shall forthwith make a true report of the result of the inspection, and that report shall be recorded in a book to be kept at the mine for the purpose, and shall be signed by the persons who made the inspection; and if the report state the existence or apprehended existence of any danger, the owner, agent, or manager shall forthwith cause a true copy of the report to be sent to the Inspector of the district.

Rule 39. *Coal-getter working alone.*—No person not now employed as a coal or ironstone getter shall be allowed to work alone as a coal or ironstone getter in the face of the workings until he has had two years' experience of such work under the supervision of skilled workmen, or unless he shall have been previously employed for two years in or about the face of the workings of a mine. (S. 49.)

38. *False Statement of Qualification under General Rule* 39.—The employment of a person at a mine in working alone as a coal or ironstone getter, not being qualified for such work pursuant to General Rule 39, if taking place on his representation that he was so qualified, and on the acceptance in good faith of such representation, shall not involve the owner, agent, or manager of the mine in the responsibility for such a contravention of the Act, but the person making the misrepresentation shall be held guilty of an offence against the Act. (S. 64.)

39. *Responsibility for Offences against the General Rules.*—Every person who contravenes or does not comply with any of the General Rules in this Act shall be guilty of an offence against this Act.

SPECIAL RULES.*

40. *Purpose of Special Rules.*—Special Rules must be established in every mine appropriate to the particular state and circumstances of each mine, to serve for the conduct and guidance of the persons acting in the management of the mine, and of those employed in or about the mine, with a view to prevent dangerous accidents, and to provide for the safety, convenience, and discipline of those employed in or about the mine.

Any person offending against the Special Rules commits an offence against the Act. (S. 51.)

41. *Making of Special Rules.*—Special Rules are proposed by the owner, agent, or manager, and transmitted to the Inspector of the district for

---

* For provisions of the Coal Mines Regulation Act, 1896, as to Special Rules, see page 392.

approval by the Secretary of State. A copy of the proposed Special Rules, together with a printed notice specifying that any objection to the Rules on the ground of anything contained therein or omitted therefrom may be sent by any of the persons employed in the mine to the Inspector of the district at his address stated in the notice, shall, during not less than two weeks before the rules are transmitted to the Inspector, be posted up in some conspicuous place at or near the mine, where they may be conveniently read by the persons employed, and so often as the same become defaced, obliterated, or destroyed, shall be renewed with all reasonable despatch.

The copy of Special Rules shall be kept distinct from any Rules which depend only on the contract between the employer and employed. (S. 57 (3).)

The Act contains provisions for the amendment of and addition to the Special Rules.

42. *Special Danger.*—Any matter, thing, or practice in or connected with any mine or any part thereof, or with the control, management, or direction thereof by the manager, which is found by an Inspector to be dangerous or defective so as, in his opinion, to threaten or tend to the bodily injury of any person, and which is not provided against by any express provision of the Act or by any Special Rule, may by him be notified in writing to the owner, agent, or manager of the mine, and the same be required to be remedied.

PROSECUTIONS.

43. *Prosecutions.*—Summary proceedings for offences, not declared to be misdemeanours, may be prosecuted and money recovered under the Summary Jurisdiction Acts (England, s. 61; Scotland, ss. 67, 76; Ireland, s. 77), to be commenced within three months of the time when the matter of complaint or information arose (s. 62 (1)); except in case of neglect to send plans or returns of abandoned mine, when time extends to six months after abandonment, or after service of notice with respect thereto. (S. 38.)

Persons charged, who think fit, may be sworn and examined as witnesses. (S. 62 (2).)

Minutes of evidence to be taken, if required by either party. (S. 62 (3).)

Parent or guardian for misstatement of age of boy or girl, and person working alone for misstatement of time of experience as a workman, are respectively liable for such offences, and not the authorities of the mine where the employment takes place. (S. 64.)

Prosecutions against an owner, agent, manager, or under-manager for an offence not committed personally, are not to be instituted except by an Inspector, or with the written consent of a Secretary of State.

Any person doing an act which in the case of an owner, agent, or manager would be an offence against this Act, shall be guilty of an offence against the Act. (S. 59 (1).)

44. *Disqualification of Justices interested in Mines.*—The justice holdin the court of summary jurisdiction to hear cases under the Act may no except with the consent of both parties, be an owner, agent, manager, mine miner's agent, or the father, son, or brother, or father-in-law, son-in-law, o brother-in-law of the foregoing, nor director of a company owning a mine (S. 69.)

45. *Application of Fines.*—Fines, on recovery, for neglecting to sen notice of any explosion or accident, or for any offence against the Ac which has occasioned loss of life or personal injury, may be given by th Secretary of State among the persons injured and the relatives of an persons whose death may have been occasioned by the explosion, accident or offence, or among some of them.

Provided that (*a*) such persons did not in his opinion occasion o contribute to occasion the explosion or accident, and did not commit an were not parties to committing the offence; and (*b*) the fact of the paymen or distribution shall not in any way affect or be receivable as evidence i any legal proceeding relative to or consequential on the explosion, accident or offence. (S. 70.)

POSTING ABSTRACT OF ACT AND SPECIAL RULES.

46. A copy of the Special Rules established at a mine, together with copy of the Abstract of the Act, with the name of the mine, the name an address of the Inspector of the district, and the names of the owner o agent and manager appended thereto, shall be posted up in legible cha acters in some conspicuous place at or near the mine, where they may b conveniently read by the persons employed; and so often as the sam become defaced, obliterated, or destroyed, they shall be renewed with a reasonable despatch. (S. 57 (1).)

Printed copies of the Abstract and Special Rules shall be issued grat to persons employed about the mine upon application at the office whe such persons are paid. (S. 57 (2).)

To pull down, injure, or deface any notice or document required b this Act to be posted up is an offence against the Act. (S. 58.)

Name of the Mine—

Where situated—

Name of the Owner—

Name of the Agent—

Name of the Manager—

Name of the Under-Manager—

Name and Address of the
Inspector of Mines of
the District

III. (A).—FORM OF SPECIAL RULES*

ESTABLISHED UNDER THE COAL MINES REGULATION ACT, 1887, FOR THE CONDUCT AND GUIDANCE OF THE PERSONS ACTING IN THE MANAGEMENT OF OR EMPLOYED IN OR ABOUT COLLIERY, IN THE COUNTY OF DURHAM.

The Special Rules herein set forth shall, so far as is reasonably practicable, be observed by the several officials under whose names or descriptions the same are respectively set, and by all workmen and others to whom the same respectively apply, and any person who acts in contravention of, or fails to comply with any of them, shall be guilty of an offence against the Act; and the officials shall, to the best of their ability, enforce the observance of the Act and Special Rules, and shall have power to suspend any one infringing, or attempting to infringe the same, and to order him out of or from the mine.

AGENT.

1. The owner or agent of the mine shall nominate himself or some other person to be the manager of the mine, and shall, when required, nominate the under-manager.

CERTIFICATED MANAGER

(*Hereinafter called "Manager"*).

2. He shall be responsible for the control, management, and direction of the mine, and shall himself, or by an under-manager where appointed, exercise daily personal supervision of the mine; and shall comply with the requirements, and to the best of his power, enforce the observance of the

---

* Special Rules vary in different mining districts, and sometimes at individual collieries in the same district, it being required by the Coal Mines Regulation Act, 1887, that Special Rules be established, "appropriate to the particular state and circumstances of each mine," in addition to the General Rules given in the Act. For the course of making Special Rules, see sections 40 and 41 of the Act (Abstract of Act, *ante*, page 329). See also provisions of the Coal Mines Regulation Act, 1896, page 392.

Act and of the Special Rules, and shall appoint such competent persons as may be necessary for carrying out the provisions of the Act.

3. He shall give attention to any complaint, and inspect, or cause to be inspected, such parts of the mine as may be reported to him unsafe and to need attention, and shall receive and examine the official reports (or copies thereof) required by the Act and Special Rules.

4. He shall see that printed notices are hung up in proper places, and renewed when obliterated, relating to the codes of signals to be used in the shafts and on incline and engine planes, and the number of persons to descend and ascend in a cage at one time; he shall appoint the station or stations required by General Rule 4 and by the Special Rules, and indicate their positions in the mine by printed or painted notices in large type; and he shall keep, or cause to be kept, at the office at the mine, the registers of boys, girls, and women as required by the Act.

CERTIFICATED UNDER-MANAGER

(*Hereinafter called "Under-Manager"*).

5. When an under-manager is appointed, he shall assist the manager in the discharge of all duties connected with the management of the mine, and, so far as not otherwise provided by the Act, he shall, in the absence of the manager, perform the same duties, have the same responsibilities, and be subject to the same liabilities as the manager.

OVERMAN.

6. He shall, under the direction of the manager or under-manager, have the daily supervision and responsible charge underground of the mine or portion of the mine, and when by nomination and appointment acting as under-manager he shall perform, in addition, the duties of under-manager.

7. He shall examine the barometer and thermometer at bank before going down the pit, and register their indications; and use extra caution when any sudden or unusual change has taken place.

8. He shall inspect such parts of the mine as may be reported to him unsafe, and in any way needing his attention, and so far as practicable remedy any defect.

9. He shall once every day visit as many of the working places in the mine as (having regard to his other duties) it may be reasonably practicable for him to visit; and shall instruct the back overman or other authorised official each working day to visit those working places where he has not been, so that every working place may be visited every working day.

10. He shall see that a sufficient quantity of suitable timber and other material is sent into the mine and into the districts of the mine where

needed; and report any deficient supply of timber or other material to the manager or under-manager.

11. He shall observe daily the main air-currents at the shaft, and also the air-currents in the districts he visits, and if there be any deficiency, ascertain the cause, and take the proper steps for having it remedied; he shall travel, from time to time, the air courses, in order to make himself thoroughly acquainted with the same, and at all times use the greatest care in examining the workings and edges of goaves.

12. He shall examine all doors, stoppings, and air-crossings in the workings, and see that they are kept in repair, and that all frame doors are so hung as to fall to and close of themselves.

13. If any part of the mine be foul he shall take steps for having it remedied; and report to the manager or under-manager and master wasteman.

14. He shall see that sufficient manholes or places of refuge are provided as required by the Act, and kept constantly clear; and that sufficient travelling way is maintained for horses and ponies where used in his department.

15. Before holing into any place not in working he shall use additional caution, and carry out General Rules 8 and 13, and in approaching any abandoned and inaccessible workings where an accumulation of gas may be expected, he shall cause a bore-hole to be kept in advance.

16. He shall not leave the mine without communicating with the back overman; and he shall daily consult with and advise the deputies, back overmen, master wasteman, master shifter, and other heads of departments on all matters connected with the state of the mine.

17. He shall examine daily the back overman's and deputies' official reports, and see that they are properly recorded; and shall enter the results of his observations each day into his report book, and sign the same and forward a copy to the manager or under-manager.

18. He shall not employ any boy under the age of twelve years; he shall see that the time and hours of working, as specified in the Act for boys between the ages of twelve and sixteen, are properly carried into effect; and shall keep a register in which he shall enter the name, age, residence, and date of first employment of every boy under his charge.

BACK OVERMAN.

(In the Day, Middle, or Night Shift.)

19. He shall have responsible charge underground of the mine or portion of the mine in the absence of the overman.

20. He shall examine the barometer and thermometer at bank on leaving the pit, and register their indications; and use extra caution when any sudden or unusual change has taken place.

[illegible] He shall visit every working day, so far as practicable, those working places in the mine which the overman or other authorised official has not visited.

22. He shall see that a sufficient quantity of suitable timber and other material is sent into the districts of the mine where needed; and report any deficient supply of timber or other material to the overman.

23. He shall see that all manholes or places of refuge are kept constantly clear, and that sufficient travelling way is maintained for horses and ponies where used in his department.

24. He shall ascertain that all the workmen and boys under his charge are safely out of the mine, but should it be necessary for any to remain, he shall ascertain that they are left in charge of a responsible person.

25. He shall confer daily with the overman, master shifter, and deputies on the state of the mine.

26. He shall carry out in his shift Rules 8, 11, 12, 13, 15, and 17 under the head of overman.

MASTER WASTEMAN.

27. He shall, under the direction of the manager or under-manager, have charge of the ventilation of the mine on the outbye side of the working headways, including both intake and return air-courses; and shall see that the air-courses are maintained of adequate size for the quantity of air necessary to keep the working places of the shafts, levels, stables, and workings of the mine, and the travelling roads to and from such working places, free from noxious gases.

28. He shall advise daily with the overmen, and confer daily with the manager or under-manager as to the condition of his department; and not make any change in the mode of ventilation without first obtaining the sanction of the manager or under-manager.

29. Where safety-lamps are required to be used, he or some authorised person shall carefully examine the safety-lamp of every workman under his charge, to see that it is in safe working order and securely locked before permitting him to go beyond the caution board.

30. He shall have control of the regulators, and prevent, as far as possible, any improper interference with them, and in all cases see that they are kept securely fastened. He shall examine and keep in repair all stoppings, air-crossings, regulators, and doors belonging to his department, and shall see that no door is propped or fastened back on its hinges, that all frame doors are so hung as to fall to and close of themselves, that all doors into the waste are securely fastened, and that all doors between main intakes and returns are double.

31. He shall frequently examine the main intake and return air-currents and goaf edges; and if any part of the mine in his department be foul, he

shall take steps for having it remedied, and report to the manager or under-manager.

32. He, or some person or persons appointed by the manager, shall travel the main returns at least once a month, and shall see that the furnace and boiler drifts are cleaned when necessary, and that the furnaces are ready for being lighted when not in use, and shall frequently travel the airways at the sides of the said drifts.

33. He shall see that sufficient travelling way is maintained for horses and ponies where used in his department.

34. He shall see that the quantities of air in the respective splits or currents are measured at least once in every month, and the results entered in a book kept at the mine for the purpose.

35. He shall report the results of his observations each day to the manager or under-manager.

MASTER SHIFTER.

36. He shall have responsible charge underground of the mine or portion of the mine in his shift during the absence of the overman and back overman.

37. Where safety-lamps are required to be used, he or some authorised person shall carefully examine the safety-lamp of every workman under his charge, to see that it is in safe working order and securely locked before permitting him to go beyond the caution board.

38. He shall keep secure all waggon ways and travelling ways, and make frequent examinations above loftings and under scaffolds.

39. He shall provide sufficient manholes or places of refuge in all places required by the Act up to the inbye end of the flat, and keep the same constantly clear; and see that sufficient travelling way is maintained for horses and ponies where used.

40. He shall observe daily the main air-currents at the shaft, and also the air-currents in the districts he visits, and if there be any defect, take steps for having it remedied, and report the same to the overman and manager or under-manager.

41. He shall not leave the mine without communicating with the official or officials who then take charge of the mine; he shall confer with the overmen and back overmen daily on the state of the mine, and shall report the results of his observations each day to the manager or under-manager.

DEPUTY.

42. Each deputy shall have the responsible charge of the portion of the mine assigned to him, under the direction of the overman or back overman.

43. The fore-shift deputies shall descend before the hewers, and each

deputy shall, within two hours before the hewers under his charge commence work, carefully examine in accordance with General Rule 4 all the working places and all places situate beyond the meeting station or flat in which workmen are to work or pass during that shift, using a locked safety-lamp where required by such Rule; and he shall properly fence, across the whole width, all entrances to places not in actual use or course of working and extension, or which are unsafe from want of timber or other cause; and if the danger arises from noxious or inflammable gases he shall also fix a danger board at a sufficient distance from the point of danger. A report of every such inspection shall be recorded in a book to be kept at the mine for the purpose, and shall be signed by, and so far as the same does not consist of printed matter shall be in the handwriting of, the person who made the inspection.

44. A similar inspection shall be made by each fore-shift and back-shift deputy in the course of each shift of all parts of the mine beyond the meeting station, in which workmen are to work or pass during that shift, but it shall not be necessary, except where inflammable gas has been found, to record a report of the same in a book.

45. Where safety-lamps are required to be used and have been previously examined and locked under General Rule 10, he shall externally examine the safety-lamp of every workman under his charge, to see that it is in safe working order and securely locked, before permitting him to go beyond the meeting station; and shall not allow a naked light or unlocked safety-lamp to be carried past a caution board on any pretence whatever; he shall see that the workmen using safety-lamps suspend them on proper stands or props, and shall take charge of any safety-lamp receiving any injury, and report the particulars to the overman.

46. Each deputy shall be responsible for having ready and putting into or near to every working place under his charge a sufficient quantity of suitable timber, brattice, sprags, and other materials; and (except as provided in Rule 92) for setting sufficient timber to afford the greatest possible safety to the workmen employed; and he shall report any deficiency of timber, brattice, sprags, or other materials to the overman or back overman.

47. He shall see that all tramways are properly secure and kept in a working state, and shall keep in good repair all doors, sheet or wood stoppings, brattice and fences in the workings, and brattice all working places where necessary, in the portion of the mine assigned to him.

48. On the inbye side of the flat he shall provide sufficient manholes or places of refuge, and keep the same constantly clear, and see that sufficient travelling way is maintained for ponies where used.

49. Where danger is apprehended from inflammable gas, he shall draw no juds until the pit is done working.

50. He shall attend to the indications of the barometer and thermometer, and use extra caution when any sudden or unusual change has taken place.

51. He shall examine the edges of the goaves adjoining working juds, and shall immediately withdraw every workman from any place rendered unsafe from want of timber or other cause, and fence off such place across the whole width, and if the danger arises from noxious or inflammable gases he shall also fix a danger board or other signal at a sufficient distance from the point of danger, report the same to the overman, and enter a record thereof in a book kept at the mine for the purpose.

52. He shall not allow any door to be fastened or propped back on its hinges, and shall see that every door is so hung that it will fall to and close.

53. He shall travel from time to time such air-courses as the manager or under-manager may direct.

54. He shall, at the close of each day's work, ascertain that the whole of the men and boys are out of the portion of the mine assigned to him; but should it be necessary for any of them to remain, he shall ascertain that such persons are left in charge of a responsible person; and before leaving, he shall ascertain that all unnecessary lights are extinguished and see that all main doors are closed, and that the ventilation is taking its proper course.

55. Each back-shift deputy shall each night report the state of the portion of the mine assigned to him to the overman or back overman.

56. Each deputy shall to the best of his ability enforce the observance of the Act and Special Rules, and shall have power to suspend any one infringing or attempting to infringe the same, and to order him out of the mine, and shall report the case to the overman or other official in charge of the mine.

ENGINEER.

57. He shall, under the direction of the manager, have the responsible charge of the engines, boilers, and the whole of the machinery with its appendages in and about the mine, and all erections on the surface; and he must see that they are kept in thorough and efficient repair, and, where required, securely fenced; and he shall, as occasion requires, confer with the manager or under-manager and foreman enginewright.

58. He or some competent person or persons appointed by the engineer, with the consent of the manager, shall have charge of, inspect, and direct the repairs of all engine, coal, and other shafts; and shall see that every cage in which persons descend or ascend the shafts is provided with a bar or chain to hold on by.

59. He shall see that a record is kept of the extent and nature of all repairs done to the boilers, the date when any boiler is cleaned, and the

name of the person by whom the same was examined after having been cleaned or repaired.

60. He shall carry out the provisions of General Rule 25, with respect to providing proper means of signalling; and, where required by General Rule 26, he shall place on the winding engine indicator a painted mark lettered "7 fathoms," so as to show when the ascending cage has reached a point in the shaft 7 fathoms from the flatsheets.

61. He or some competent person or persons appointed by the manager, shall inspect such parts of the machinery or other works in his department as may be reported unsafe and in any way to need attention, and, so far as practicable, remedy any defect.

62. He shall not employ any boy under the age of twelve years; and shall see that a register is kept of the name, age, residence, and date of first employment of every boy under his charge in or about the mine.

FOREMAN ENGINEWRIGHT.

63. In the absence of the engineer he shall have the responsible charge of the engines, boilers, and the whole of the machinery with its appendages in and about the mine, and all erections on the surface; and he must keep them in thorough and efficient repair, and, where required, securely fenced.

64. He or some competent person or persons appointed by the manager shall, once at least in every twenty-four hours, examine the state of the external parts of the machinery, the state of the guides and conductors in the shafts, and the state of the head gear, ropes, chains, and other similar appliances of the mine which are in actual use both above ground and below ground, and shall also, once at least in every week, examine the state of the shafts by which persons descend or ascend, and record and sign a true report of the result of such examination in the book provided for the purpose.

65. He or some competent person or persons appointed by the manager shall examine the ropes and chains of the pit crab, gin, jack and cradle, daily when in use, and after being out of use more than twenty-four hours immediately before use, and remove or repair them when necessary; and anneal the working cage chains once at least during every six months, and clean and refit the safety detaching hooks, where used, once at least during every three months, recording all particulars of the same in a book.

66. He or some competent person or persons deputed by the engineer, with the consent of the manager, shall examine from time to time all boilers, to see that they are in a fit state for work; and shall instruct the fireman or boiler-minder in the working and regulation of all fittings, and once a day see that they are free and in good order; and shall when any boiler has been cleaned and reported by the person in charge as being ready for inspection, examine it internally, and also the fittings, and so

boiler shall be set to work until it has been so examined and found in a fit state for work.

67. He or some competent person or persons appointed by the manager shall inspect such parts of the machinery or other works in his department as may be reported unsafe and in any way to need attention, and so far as practicable remedy any defect, and shall report all defects and alterations needed, to the manager or under-manager and engineer, and in the absence of the engineer confer daily with the manager or under-manager.

68. In the absence of the engineer he shall carry out Rules 58, 59, and 62, under the head of engineer.

WINDING ENGINEMAN.

69. The engineman shall once a day thoroughly examine his engine rope rolls and flanges or horns, the ropes upon the rolls or drums, the brake, and the signal bell or indicator showing the position of cage in the shaft, and shall immediately report any defect he may observe to the engineer, foreman enginewright, or other authorised person for the time being appointed by the manager.

70. He shall have a thorough understanding of the signals in use, and attend to them, and on no account start his engine until he has received the proper signal. If a signal be indistinct, he must not move the engine until it has been repeated and he clearly understands it.

71. He shall not on any pretext leave the handles whilst the engine is in motion.

72. He shall not allow any one to be in the engine-house or to work the engine without the permission of the manager or engineer.

73. When raising or lowering persons, he shall work the engine by hand at a slow speed; and if no automatic contrivance to prevent overwinding is attached to the winding apparatus or ropes, he must, on reaching the point on the indicator marked "7 fathoms," reduce the speed of the cage in the shaft to not more than 3 miles an hour.

74. He shall leave the cages so as to impede the ventilation as little as possible; and after the cages have stood for the space of one hour or longer, he shall run them in the shaft once before allowing men to ride.

75. When there is no boiler-minder, he shall carry out Rules 77, 78, 79, and 80.

OTHER ENGINEMEN.

76. Every person attending and for the time being having charge of any hauling, fan, pumping or other engines, or of machinery for working a plane or incline, shall carry out Rules 69, 70, 72, 77, 78, 79, and 80. so far as they may be applicable.

BOILER-MINDER, OR FIREMAN.

77. He must examine particularly, from time to time during his shift the donkey engine or other feed apparatus, boiler fittings, and dampers and see that they are in good working order; and shall at once report t the engineer or foreman enginewright and engineman any defect in th boilers, tubes, dampers, and fittings.

78. After a boiler has been cleaned or repaired, he or some competen person must examine it internally, and also the mountings and fittings, an if satisfied that it is in a fit state to be worked, report the same to th engineer or foreman enginewright; and after a boiler has been out of use he shall not relight the fires unless authorised by the engineer or forema enginewright.

79. He shall keep the water in each boiler at the fixed working leve so far as practicable, but if it becomes, from any cause, too low, he shal at once lower the dampers, and either draw the fire or damp it down, an report to the engineer or foreman enginewright and engineman.

80. He shall strictly observe and carry out the directions of the enginee or foreman enginewright in the management and working of the boilers.

HEAPKEEPER.

81. He shall have charge of the heapstead, screens, and ambulanc arrangements, and see that all unnecessary fires are extinguished when th pit is done drawing coals.

82. He shall not employ any boy under sixteen years of age in movin railway waggons, and shall see that the time and hours of working a specified in the Act for boys between the ages of twelve and sixteen ar properly carried into effect.

83. He shall not employ any boy under the age of twelve years; an shall keep a register in which he shall enter the name, age, residence, an date of first employment of every boy employed above ground.

BANKSMAN AND ONSETTER.

84. Each banksman shall have control of the shaft top, and eac onsetter of the shaft bottom, and shall not allow any person to descend ascend the pit without permission from the proper authority; he sha regulate, subject to any directions of the manager or under-manager, th order in which persons shall enter and leave the cage, and see that th authorised number only descend or ascend at one time; and shall n allow any person to descend in a state of intoxication, nor allow any into cating drink to be taken down the pit, except by special permission.

85. He shall make himself thoroughly acquainted with the signals; shall not allow any unauthorised person to interfere with the means

signalling; and shall not allow any one to descend or ascend on the cage top, or to take any gear with him into the cage, without permission, nor allow persons to descend or ascend with or against a loaded tub.

86. When persons are to descend or ascend, the agreed signal shall be given by the banksman or onsetter only, except where otherwise authorised; and when persons are descending or ascending the banksman and onsetter shall remain in a position so as immediately to signal the engineman in case of an accident.

87. He shall remain in attendance where his duties require him after the pit is done; and shall not leave the shaft without seeing the rails, chains, or gates at the opening into the pit in their proper position; he shall keep the flatsheets, cages, and all places near the shafts free from coal, stone, and loose material; and he shall, where shifts are continuous, "change" at the shaft so as to ensure proper attention when the cages are being worked.

88. He shall at once report to the engineer, foreman enginewright, or other authorised person, any defect he may observe in the ropes, chains, cages, signals, or other apparatus, and prevent the use of the same until examination has been made and they have been authorised to be again used; and he shall to the best of his power enforce the observance of the Act and Special Rules, and report any infringement or attempted infringement of the same to the overman and manager or under-manager.

UNDERGROUND WORKMEN AND BOYS.

89. If safety-lamps are directed by the manager to be used in the mine or in any district of the mine, all persons employed therein shall strictly observe the regulations under the head of "safety-lamps," hereinafter contained.

90. Every workman and boy shall strictly attend to the directions of the manager and other authorised persons with respect to the use of safety-lamps, and to all other matters connected with the working of the mine and the proper discipline of the persons employed therein.

91. No workman or boy shall, unless and until authorised, go beyond the appointed meeting station, or any fence, danger board, or other recognised signal, nor, except in case of necessity, into any other part of the mine than that in which he is placed by the overman, deputy, or other official.

92. Should the working place of any man or boy become unsafe, from any cause, he shall discontinue working in it, and immediately send or go for the deputy; but if unsafe from want of timber being set, then, in the absence of the deputy, there being sufficient timber of proper lengths in or near to the place, he shall set it, in order to keep himself safe, or shall cease to work and retire therefrom, and report the same to the deputy or other official; and in all cases, where necessary, he shall sprag his jud.

93. No person, unless authorised, shall interfere with or alter any timber set to support the roofs or sides, or any ventilating door, regulator, brattice, switch, means of signalling, or other appliance; and no person shall prop or fasten back any door on its hinges.

94. No person shall attempt to enter or leave the cage whilst in motion, and every person shall enter or leave the cage as and when ordered to do so by the banksman, onsetter, or other authorised person, and no person unless authorised shall take any gear with him in the cage.

95. No workman or boy shall ride upon any animal, tub, or tram, or any incline, engine-way, horse-way, or tramway without permission.

96. Where underground trains are permitted to be run for the convenience of workmen, they shall be under the entire charge of the guard appointed to look after them, and no person shall attempt to get into or out of the train while in motion, nor refuse to enter or leave it when directed to do so by the guard; any person refusing to comply with this rule, or interfering with or obstructing the guard in the discharge of his duties, shall be reported by him to the official in charge of the mine.

97. All persons who are casually employed underground (masons, enginewrights, and others) shall be amenable to the Act and the Special Rules, and shall make themselves acquainted with the same.

98. Any person, having charge of any horse, pony, or tub, shall be responsible for all injuries they may receive while in his charge through his wilful act or negligence, and shall exercise care in the management thereof, so as to prevent injury thereto or to himself or other persons, and shall use cotters, sprags, and cows where ordered to do so or where necessary for safety; and no person shall, unless otherwise authorised, give his horse or pony into the charge of any other person than the horse-keeper at the stables.

SAFETY-LAMPS.

99. *Wherever from time to time in any portion of the mine safety-lamps are directed by the manager to be used, all persons employed therein shall strictly observe the following regulations with reference thereto:—*

100. Every person to whom a safety-lamp is entrusted is responsible for it until returned by him to the lamp room.

101. Each person must receive his safety-lamp (or lamp bottom where the entire lamp is not in charge of the lamp keeper) from the lamp room, and having seen that it is in safe working order, must present it to the authorised person for examination at the lamp locking station appointed by the manager, and must also present it to the deputy or other authorised person for external examination at the meeting station; and he is strictly prohibited from interfering with it, in any way whatever, whilst in use, beyond the necessary trimming of the wick.

102. Each person on his return from the mine must take his safety-lamp (or if by reason of some accident, or other cause, his lamp has been changed by the deputy or other authorised person, then the safety-lamp in his possession) to the lamp room, and inform the lamp keeper of any change that may have taken place in it, or in regard to it during the time it has been in his possession. Where the entire safety-lamp is not left in charge of the lamp keeper, the lamp keeper shall retain the oil vessel, but the top of the safety-lamp and gauze must be taken home and cleaned by the person using it, every time it is used; and if any repairs are required to it, he shall take it to the person authorised to repair lamps. When a safety-lamp is enclosed in a tin or other outer case, such case forms part of the safety-lamp.

103. At such point or points in the mine as the manager may from time to time direct, a station or stations shall be appointed, at which caution boards shall be fixed. Beyond such station no person under any pretence whatever shall take an unlocked safety-lamp, candle, lantern, naked light, tobacco pipe, or material or apparatus of any kind for obtaining a light, or a safety-lamp which has not been first carefully examined at the lamp locking station by some authorised person to see that it is in safe working order and securely locked.

104. At such point or points in the mine as the manager may from time to time direct, meeting stations shall be appointed, beyond which no person shall go without permission of the deputy or other authorised person, nor unless his safety-lamp has been externally examined there by such authorised person.

105. No person, unless authorised in writing by the manager or under-manager, shall unlock a safety-lamp when in the mine.

106. The deputies and other officials of the mine have full power to direct each workman how to use his safety-lamp; and it is particularly enjoined that every workman strictly attend to such directions.

107. Every person using a safety-lamp shall frequently notice it, and should he observe any indication of inflammable gas in his lamp, he shall draw down the wick within the tube, carefully and slowly retire with the lamp to a safe place, and immediately report to the deputy.

108. When not being carried, a safety-lamp shall be suspended on a proper stand or prop, and shall not be placed within 2 feet of goaf or old workings, nor within 2 feet from the stroke or swing of any pick or other gear.

109. Should any person in charge of a safety-lamp lose his light, he shall take it himself to the meeting station; and should any accident happen to a safety-lamp whilst in use, by which the gauze is injured, oil spilled upon the gauze, glass broken, or the lamp in any other way damaged, the person using such lamp shall immediately extinguish it by drawing the

wick down within the tube, and shall give the lamp into the charge of the deputy, who at the end of his shift shall give it to the lamp keeper.

110. No official or workman must allow any gas to explode in his safety-lamp under any circumstances where it can be avoided. Where necessary to try for or examine for the presence of gas, the safety-lamp must not be raised higher than will allow the presence of the gas to be detected.

111. No person shall use any other safety-lamp than his own, or the one given to him by the deputy or other authorised person, and no person shall, under any pretence whatever, improperly treat, interfere with, or damage, whether wilfully, negligently, or otherwise, his own or any other safety-lamp in any way whatever.

112. It is expressly directed that any workman or other person witnessing any improper treatment of a safety-lamp by any one, shall give immediate information to the deputy or other official then in charge of the district.

113. All safety-lamp keys authorised to be used shall be officially stamped and numbered; and no official or workman, under any pretence whatever, shall have in his possession a key or any contrivance for opening a safety-lamp, unless holding a written authorisation from the manager or under-manager of the mine in which he is employed; nor shall any person authorised to have a safety-lamp key have in his possession any other safety-lamp key than the one officially given to him. When required by the manager or under-manager all persons having safety-lamp keys and authorisations shall produce them; and each person on leaving the colliery or changing his employment shall deliver up his safety-lamp key and authorisation to the manager or under-manager.

SHOT-FIRING.

114. In any place where locked safety-lamps are required to be used or which is dry and dusty:—

(*a.*) No shot shall be fired except by or under the direction of a competent person appointed by the manager.

(*b.*) Every person when about to fire or direct the firing of a shot shall in all cases adhere strictly to the regulations contained in General Rule 12; and, after firing, shall return and carefully examine the roof and sides of the place.

(*c.*) In all cases the person or persons authorised to fire shots shall fire or direct the firing in manner approved from time to time by the manager.

(*d.*) Whenever it is necessary to begin or resume the use of gunpowder or other explosive, or to fire a shot in any return airway or main haulage road, the official in charge must first obtain permission from the manager or under-manager.

115. Before firing a shot in any place which is likely to be holed by such shot into another place, the person about to fire the shot shall first examine the place into which he is likely to hole, and satisfy himself that no person is in it at the time; and every person about to fire a shot in a hewing place shall take precautions to prevent any person going past the end of such place until after the shot has exploded.

116. Wherever the charge of a shot has missed fire, no person shall return to the place until after an interval of not less than ten minutes, unless the shot was attempted to be fired by some electrical appliance.

GENERAL REGULATIONS.

117. No person shall wilfully damage or without proper authority remove or render useless any fence, fencing, manhole, place of refuge, casing, lining, guide, means of signalling, signal, notice or notice board, cover, chain, flange, horn, brake, indicator, steam gauge, water gauge, safety-valve or other appliance, or anything in or about the mine.

118. Any person observing a door, used for the purpose of ventilation, standing open, or stoppings injured, or anything out of order whereby the ventilation of the mine or its safety in other respects may be affected, shall immediately inform the overman, deputy, or other official, so that there may be as little delay as possible in applying a remedy.

119. Every workman or boy shall strictly adhere to the General and Special Rules and to the regulations contained in the various notices fixed for their safety and guidance in or about the mine; and any person who may observe or have a knowledge of any neglect or infringement of the same shall report the case to an official, so that immediate means may be taken for applying a remedy.

120. No person shall depute any one to do his work without the sanction of his official superior.

121. No fighting, or throwing of stone, coal, or other missiles, is allowed in or about the mine.

122. No person shall have in his possession any intoxicating drink without permission, or be in or about the mine in a state of intoxication.

123. No person shall be allowed to smoke in or at the mine without permission.

124. All notices fixed in or about the mine must be authorised by the manager or under-manager, and no person shall in any way damage, deface, or remove any such notice.

125. Every person receiving any personal injury in or about the mine shall, before leaving the mine, report the same to one of the officials.

126. Every person employed in or about the mine is enjoined to thoroughly acquaint himself with the General and Special Rules.

127. Any workman or boy who neglects to observe any of the provisions of the Act and Special Rules, or refuses obedience to the orders of the officials, or interferes with, impedes, or obstructs any person in the discharge of his duties, or interferes with or obstructs the working of the mine, shall be suspended and ordered out of or from the mine.

128. Any person suspended and ordered out of or from the mine for breach of the Act, Special Rules, or other cause, shall not be re-employed until authorised by the manager or under-manager.

129. Where the duties of more than one department are entrusted to the same person, that person shall be bound by and observe the rules attached to all such departments.

130. Where by these rules any duty is imposed upon, or authority given to any under official of the mine, that duty may be fulfilled or that authority exercised by and at the discretion of any official his superior at the mine.

131. Any person employed in or about the mine wilfully or negligently doing anything likely to endanger life or property, or any one observing anything as aforesaid being done, and not reporting the same to the official in charge, will be deemed guilty of a breach of these rul

Name of Mine or Colliery—

Situation of Mine—

County of—

Name of Owner (or Company)—

Name of Agent—

Name of Manager—

Name of Under-Manager—

Name and Address of the
Inspector of Mines for
the District

III.—(B) SPECIAL RULES FOR THE INSTALLATION AND USE OF ELECTRICITY.

(*Issued by the Home Office*, 1905.)

The following Rules shall be observed, as far as is reasonably practicable, in the mine.

DEFINITIONS.

The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and earth as read by a hot wire or electrostatic volt-meter, and

(*a.*) Where the conditions of the supply are such that the pressure at the terminals where the electricity is used cannot exceed 250 volts, the supply shall be deemed a low-pressure supply.

(*b.*) Where the conditions of supply are such that the pressure at the terminals where the electricity is used, between any two conductors, or between one conductor and earth, may at any time exceed 250 volts, but cannot exceed 650 volts, the supply shall be deemed a medium-pressure supply.

(*c.*) Where the conditions of supply are such that the pressure at the terminals where the electricity is used, between any two conductors, or between one conductor and earth, may at any time exceed 650 volts, but cannot exceed 3,000 volts, the supply shall be deemed a high-pressure supply.

(*d.*) Where the conditions of supply are such that the pressure at the terminals where the electricity is used, between any two conductors, or between one conductor and earth, may at any time exceed 3,000 volts, the supply shall be deemed an extra high-pressure supply.

SECTION I.

GENERAL.

1. (*a.*) All electrical apparatus and conductors shall be sufficient in size and power for the work they may be called upon to do, and, so far as is reasonably practicable, efficiently covered or safeguarded, and so installed, worked, and maintained as to reduce the danger through accidental shock or fire to the minimum, and shall be of such construction and so worked that the rise in temperature caused by ordinary working will not injure the insulating materials.

(*b.*) In any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, the covering shall be constructed so that, as far as is reasonably practicable, there is no danger of firing gas by sparking or flashing which may occur during the normal or abnormal working of the apparatus.

(*c.*) All metallic coverings, armouring of cables, other than trailing cables, and the frames and bedplates of generators, transformers, and motors, other than portable motors, shall, as far as is reasonably practicable, be efficiently earthed where the pressure at the terminals where the electricity is used exceeds the limits of low pressure.

2. Where a medium-pressure supply is used for power purposes, or for arc lamps in series, the wires or conductors forming the connections to the motors, transformers, arc lamps, or otherwise in connection with the supply, shall be, as far as is reasonably practicable, completely enclosed in strong armouring or metal casing efficiently connected with earth, or they shall be fixed at such a distance apart, or in such a manner, that danger from fire or shock may be reduced to the minimum. This rule shall not apply to trailing cables.

3. Where a medium-pressure supply is used for incandescent lamps in series the wires or conductors forming connections to the incandescent lamps, or otherwise in connection with the supply, shall be, as far as is reasonably practicable, completely enclosed in strong armouring or metal casing efficiently connected with earth, or they shall be fixed at such a distance apart, or in such a manner, that danger from fire or shock shall be reduced to the minimum.

4. Motors of coal-cutting and such other portable machines shall not be used at a pressure higher than medium pressure. No transformer used for supplying current at a pressure higher than medium pressure, and no motor using such current, shall be of less normal rating than 20 b.h.p. for use underground.

No higher pressure than a medium pressure shall be used in any place or part of the mine to which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies.

5. No higher pressure than a medium-pressure supply shall be used other than for transmission or for motors, and the wires or conductors other than overhead lines above ground forming the connections to the motors or transformers, or otherwise in connection with the supply, shall be completely enclosed in a strong armouring of metal casing efficiently connected with earth, or they shall be fixed at such a distance apart, or in such a manner that danger from fire or shock shall be reduced to the minimum.

The machines, apparatus, and lines shall be so marked as to clearly indicate that they are high pressure, either by the use of the word "Danger" at frequent intervals, or by red paint properly renewed when necessary.

6. The insulation of every complete circuit other than telephone or signal wires used for the supply of energy, including all machinery, apparatus, and devices forming part of or in connection with such circuit, shall be so maintained that the leakage current shall, so far as is reasonably practicable, not exceed $\frac{1}{1000}$ of the maximum supply current, and suitable means shall be provided for the immediate localisation of leakage.

7. In every completely insulated circuit, earth or fault detectors shall be kept connected up in every generating and transforming station, to show immediately any defect in the insulation of the system. The readings of these instruments shall be recorded daily in a book kept at the generating or transforming station or switch-house.

8. Main and distribution switch and fuse boards must be made of incombustible insulating material, such as marble or slate free from metallic veins, and be fixed in as dry a situation as practicable.

9. Every sub-circuit must be protected by a fuse on each pole. Every circuit carrying more than 5 ampères up to 125 volts or 3 ampères at any pressure above 125 volts, must be protected in one of the following alternative methods:—

(*a.*) By an automatic maximum cut-out on each pole.

(*b.*) By a detachable fuse on each pole, constructed in such a manner that it can be removed from a live circuit with the minimum risk of shock.

(*c.*) By a switch and fuse on each pole.

10. Fire buckets, filled with clean, dry sand, shall be kept in electrical machine rooms, ready for immediate use in extinguishing fire.

No repair or cleaning of the live parts of any electrical apparatus except mere wiping or oiling shall be done when the current is on.

Gloves, mats, or shoes of indiarubber or other non-conducting material shall be supplied and used where the live parts of switches or machines working at a pressure exceeding the limits of low pressure, have to be handled for the purpose of adjustment.

11. A competent person shall be on duty at the mine when the electrical apparatus or machinery is in use; and at such time as the amount of electricity delivered down the mine exceeds 200 b.h.p., a competent person shall be on duty at the mine above ground, and another below ground. Every person appointed to work any electric apparatus shall have been instructed in his duty and be competent for the work he is set to do.

12. No person shall wilfully damage, interfere with, or without proper authority remove or render useless, any electric line or any machine, apparatus, or part thereof, used in connection with the supply or use of electricity.

13. Instructions shall be posted up in every generating, transforming, and motor house containing directions as to the restoration of persons suffering from electric shock.

14. Direct telephonic or other equivalent means of communication shall be provided between the surface and the pit bottom or main distributing centre in the pit.

15. Within three months after the introduction into any mine of electric motive power, notice in writing must be sent to H.M. Inspector of Mines for the district. Notice must also be sent of any existing electric motive power installation at any mine within three months after the coming into force of these rules.

16. A plan shall be kept at the mine showing the position of all permanent electrical machinery and cables in the mine, and shall be corrected as often as may be necessary to keep it up to a date not more than three months previously.

SECTION II.

GENERATING STATIONS AND MACHINE ROOMS.

17. Where the generating station under the control of the owner or manager of the mine is not within 400 yards of the working pit mouth, an efficiently enclosed locked switch box or boxes or a switch-house, shall

where reasonably practicable, be provided near the pit mouth, for cutting off the supply of electricity to the mine.

18. There shall be a passage way in front of the switchboard of not less than 3 feet in width, and if there are any connections at the back of the switchboard, any passage way behind the switchboard shall not be less than 3 feet clear. This space shall not be utilised as a storeroom or a lumber room, or obstructed in any manner by resistance frames, meters, or otherwise. If space is required for resistance frames or other electrical apparatus behind the board, the passage way must be widened accordingly.

No cable shall cross the passage way at the back of the board except below the floor, or at a height of not less than 7 feet above the floor.

The space at the back of the switchboards shall be properly floored, accessible from each end, and, except in the case of low-pressure switchboards, must be kept locked up, but the lock must allow of the door being opened from the inside without the use of a key. The floor at the back shall be incombustible, firm, and even.

19. Every generator shall be provided with a switch on each pole between the generator and the bus-bars.

Where continuous-current generators are paralleled, reversed current cut-outs shall also be provided.

Suitable instruments shall be provided for measuring the current and pressure of each generator.

Every feeder circuit shall at its origin be provided with an ammeter.

20. If the transmission lines from the generating station to the pit are overhead there shall be lightning arresters in connection with the feeder circuits.

21. Automatic cut-outs must be arranged so that when the contact lever opens outwards no danger exists of striking the head of the attendant. If unenclosed fuses are used they must be placed within 2 feet of the floor, or be otherwise suitably protected.

Where the supply is at a pressure exceeding the limits of medium pressure, there shall be no live metal work on the front of the main switchboard within 8 feet of the floor or platform, and the space provided under Rule No. 2 of this section shall be not less than 4 feet in the clear. Insulating floors or mats shall be provided for medium pressure boards where live metal work is on the front or back.

22. All terminals and live metal on machines over medium pressure above ground, and over low pressure under ground, where practicable shall be protected with insulating covers or with metal covers connected to earth.

23. No person other than an authorised person shall enter a machine or motor room, or interfere with the working of any machine, motor, or apparatus connected therewith.

SECTION III

CABLES.

24. All conductors (except as hereinafter provided) shall in every case be maintained completely insulated from earth, but it is permissible to use the concentric system with earthed outer conductor, if proper arrangements are made to reduce the danger from fire or shock to the minimum, but the neutral point of polyphase systems and the middle wire of three-wire continuous-current systems may be earthed at one point.

25. Unless fixed as far as is reasonably practicable out of reach of injury, all conductors, other than armoured cables, must further be protected by a suitable covering. Where lead-covered cable is used the lead shall be earthed, and electrically continuous throughout.

The exposed ends of cables where they enter the terminals of switches, fuses, and other appliances, must, as far as is reasonably practicable, be properly protected and finished off, so that moisture cannot creep along the insulating material within the waterproof sheath, nor can the insulating material, if of an oily nature, leak out of the cable.

26. All joints must be mechanically and electrically efficient, and, where reasonably practicable, must be suitably soldered. In any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, suitable joint boxes must be used, and the conductors connected by means of metal screw clamps, connectors, or their equivalent, constructed in a safe manner. Provided that in any place or part of a mine where a shot may be fired, joints may be soldered by or in the presence of a person authorised in that behalf by the manager, but the same precautions in regard to examination and removal of workmen as are prescribed by paragraphs (*f*) and (*i*) of General Rule 12 shall be observed in all cases, and where the place is dry and dusty, also the precautions as to watering prescribed by paragraph (*h*). Wires, other than signalling wires, or cables must not be joined by merely twisting them together.

27. Overhead bare wires on the surface must be efficiently supported upon insulators, and clear of any traffic, and provided with efficient lightning arresters.

28. All cables used in shafts must be highly insulated and substantially fixed. Shaft cables, not capable of sustaining their own weight, shall be properly supported at intervals varying according to the weight of the cable. Where the cables are not completely boxed in and protected from falling material, space shall be left between them and the side of the shaft that they may yield, and so lessen a blow given by falling material.

29. Where the cables in main haulage roads cannot be kept at least

1 foot from any part of the tub or tram, they shall be specially protected. When separate cables are used they shall, if reasonably practicable, be fixed on opposite sides of the road.

The fixing with metallic fastenings of cables and wires not provided with metallic covering to walls or timbers is prohibited.

Cables underground when suspended shall be suspended by leather or other flexible material in such a manner as to allow of their readily breaking away when struck, before the cables themselves can be seriously damaged.

Where main or other roads are being repaired, or blasting is being carried out, suitable temporary protection must be used so that the cables are reasonably protected from damage.

30. Trailing cables for portable machines shall be specially flexible, heavily insulated, and protected with either galvanised steel wire armouring, extra stout braiding, hose pipe, or other effective covering. Trailing cables shall be examined at least once in each shift by the person in charge of the machine, and any defects in them promptly repaired.

At points where the flexible conductors are joined to the main cables, a fixed terminal box must be provided, and a switch shall be fixed close to or in the terminal box capable of entirely cutting off the supply from the terminal box and motor.

SECTION IV.

SWITCHES, FUSES, AND CUT-OUTS.

31. Fuses and automatic cut-outs shall be so constructed as effectually to interrupt the current when a short circuit occurs, or when the current through them exceeds the working current by 200 per cent. Fuses shall be stamped or marked, or shall have a label attached, indicating the current with which they are intended to be used, or where fuse wire is used each coil in use shall be so stamped or labelled. Fuses shall only be adjusted or replaced by an authorised person.

32. All live parts of switches, fuses, and cut-outs not in machine-rooms, or in compartments specially arranged for the purpose, must be covered. These covers must be of incombustible material, and must be either non-conducting or of rigid metal, and, as far as practicable, clear of [illegible] internal mechanism.

33. All points at which a circuit other than those for signals has to be made or broken shall be fitted with proper switches. The use of hooks or

other makeshifts is prohibited, and in any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, the use of open-type switches, fuses, and cut-outs is prohibited; they must either be enclosed in gas-tight boxes, or break under oil.

SECTION V.

MOTORS.

34. All motors, together with their starting resistances, shall be protected by switches capable of entirely cutting off the pressure, and fixed in a convenient position near the motor, and every motor of 10 b.h.p. or over in a machine-room underground shall be provided with a suitable ammeter to indicate the load put upon the machine.

35. Where unarmoured cables or wires pass through metal frames or into boxes or motor casings, the holes must be substantially bushed with insulating bushes, and, where necessary, with gas-tight bushings which cannot readily become displaced.

36. Terminal boxes of portable motors must be securely attached to the machine, or be designed to form a part thereof.

37. In any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, all motors, unless placed in such rooms as are separately ventilated with intake air, shall have all their current-carrying parts, also their starters, terminals, and connections, completely enclosed in flame-tight enclosures, made of uninflammable material, and of sufficient strength as not to be liable to be damaged should an explosion of firedamp occur in the interior, and such enclosures shall not be opened except by an authorised person, and then only when the current is switched off. The pressure shall not be switched on while the enclosures are open.

38. In any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, a safety lamp or other suitable apparatus for the detection of firedamp shall be provided for use with each machine when working, and should any indication of firedamp appear on the flame of the safety lamp or other apparatus used for the detection of firedamp, the person in charge shall immediately stop the machine, cut off the current at the gate end or nearest switch, and report the matter to an official of the mine.

39. (*a.*) A coal-cutter motor shall not be kept continuously at work for a period of time exceeding a maximum period which shall be specified in writing by the manager, so that the roof may be carefully examined.

(*b.*) The casing or inspection doors of all portable motors used underground and the castings of their switches and other appliances shall at least once a week be opened by a competent person appointed by the manager, and the parts so disclosed shall be cleaned and examined before the coverings are replaced. In special cases requiring a motor to run continuously longer than one week, the motor shall be examined at the end of the run. A report of such examination shall be entered in a report book.

40. The person in charge of a coal-cutter or drilling machine shall not leave the machine while it is working, and shall, before leaving the working place, see that the current is cut off from the trailing cables. He must not allow the cables to be dragged along by the machine. No repairs shall be made to any portable machine until the pressure has been cut off from the trailing cables.

41. If any electric sparking or arc be produced outside a coal-cutting or other portable motor or by the cables or rails, the machine shall be stopped, and not be worked again until the defect is repaired, and the occurrence shall be reported to an official of the mine.

SECTION VI.

ELECTRIC LOCOMOTIVES.

42. Electric haulage by locomotives by the trolley wire system is not permissible in any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies. On this system no pressure exceeding the limits of medium pressure may be employed.

43. In underground roads the trolley wires must be placed so that they are at least 7 ft. above the level of the road or track, or elsewhere, if sufficiently guarded, or the pressure must be cut off from the wires during such hours as the roads are used for travelling on foot in places where trolley wires are fixed. The hours during which travelling on foot is permitted shall be clearly indicated by notices and signals placed in a conspicuous position at the ends of the roads. At other times no one other than a duly authorised person shall be permitted to travel on foot along the road.

On this system either insulated returns or uninsulated metallic returns of low resistance may be employed.

44. In order to prevent any other part of the system being earthed (except when the concentric system with earthed outer conductor is used) the current supplied for use on the trolley wires with an uninsulated return shall be generated by a separate machine, and shall not be taken from or be in connection with electric lines otherwise completely insulated from earth.

45. If storage battery locomotives are used in any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, the rules applying to motors in such places shall also be deemed to apply to the boxes containing the cells.

SECTION VII.

ELECTRIC LIGHTING.

46. All arc lamps shall be so guarded as to prevent pieces of ignited carbon falling from them, and shall not be used in situations where there is likely to be danger from the presence of coal dust. They should be so screened as to prevent risk of contact with persons.

47. Small wires for lighting circuits must be either conveyed in pipes or casings, or suspended from porcelain insulators, or tied to them with some non-conducting material which will not cut the covering, and so that they do not touch any timbering or metal work. On no account must staples be used. If metallic pipes are used they must be electrically continuous and earthed. If separate uncased wires are used they must be kept at least 2 in. apart, and not brought together except at lamps or switches or fittings.

48. In any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, electrical lamps, if used, must be of the vacuum or enclosed type; they shall be protected by gas-tight fittings of strong glass, and have no flexible cord connections, and shall only be changed by a duly authorised competent person. While the lamps are being changed the current shall be switched off.

49. In all machine-rooms and other places underground, where a failure of electric light is likely to cause danger, some safety lamps or other proper lights shall be kept for use in the event of such failure.

SECTION VIII.

SHOT-FIRING.

50. Electricity from lighting or power cables shall not be used for firing shots, except in sinking shafts or stone drifts, and then only when a special firing plug, button, or switch is provided, which plug, button, or switch shall be placed in a fixed locked box, and shall only be accessible to the authorised shot-firer.

The firing cables or wires shall not be connected to this box until immediately before it is required for the firing of shots, and shall be disconnected immediately after the shots are fired.

When shot-firing cables or wires are used in the vicinity of power or lighting cables, sufficient precautions shall be taken to prevent the shot-firing cables or wires from coming in contact with the lighting or power cables.

The foregoing rules shall not apply to telephone, telegraph, and signal wires, to which the rules of this section only shall apply:—

SECTION IX.

SIGNALLING.

51. All proper precautions must be taken to prevent electric signal and telephone wires from coming into contact with other electric conductors, whether insulated or not.

52. Contact makers or push buttons of electric signalling circuits shall be so constructed and placed as to prevent the circuit being accidentally closed.

53. In any place or part of a mine where General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, bare wires shall not be used for signalling circuits except in haulage roads, and the pressure shall not exceed 15 volts in any one circuit.

SECTION X.

ELECTRIC RELIGHTING OF SAFETY LAMPS.

54. In mines to any place or part of which General Rule No. 8 of the Coal Mines Regulation Act, 1887, applies, when safety lamps are relighted underground by electricity, the manager shall select a suitable station or stations, which are not in the return airway, and in which there is not likely to be any accumulation of inflammable gas; and no electric relighting apparatus shall be used in any other place. All electrical relighting apparatus

shall be securely locked, so as not to be available for use except by persons authorised by the manager to relight safety lamps, and such persons shall examine all safety lamps brought for relighting before they are re-issued.

SECTION XI.

EXEMPTIONS AND MISCELLANEOUS.

55. Notwithstanding anything contained in these rules, any electrical plant or apparatus installed or in use before the coming into force of these rules may be continued in use unless an inspector shall otherwise direct, or subject to any conditions affecting safety that he may prescribe.

In case any difference of opinion shall arise between an inspector and an owner under this Rule, the same shall be settled as provided in section 42 of the Coal Mines Regulation Act, 1887.

56. Any of the foregoing requirements shall not apply in any case in which exemption is obtained from the Secretary of State, on the ground either of emergency or special circumstances, on such conditions as the Secretary of State may prescribe.

DIREC[illegible] [illegible]USTRIES
Bengal

IV. PITMEN'S YEARLY BONDS.

YEARLY BOND DATED 23RD NOVEMBER 1767.

MR W. C. BLACKETT has kindly supplied the authors with the terms of the following old Bond:—

ARTICLES OF AGREEMENT had made and fully agreed upon this 23rd day of November for the year of our Lord 1767, between JOHN SMITH of Witton Gilbert in the County of Durham of the one part, and THE SEVERAL AND RESPECTIVE WORKMEN. In consideration of 1s. lawful money to them in hand paid for their binding money, the Receipt whereof they do hereby severally acknowledge and confess. Also in further consideration of the Rates and prices to be paid them by the said John Smith, his Heirs or Assigns, Do hereby Bind themselves separately to be his servants as Hewers and Barrowmen In and at Charlaw Colliery, In the Parish of Witton Gilbert, and County of Durham aforesaid, from the day of the date hereof for During and until the 22nd day of November 1768 Next ensuing the date hereof. And the said workmen do hereby severally promise and agree to and with the said John Smith that they will and well truly work for and abide with the said John Smith and no other person as his Hewers and Barrowmen at the said Colliery for the time aforesaid. And the Several Workmen agree that the said John Smith shall keep and detain out of our wages 1s. for every day which we or any of us disturbeth the work or refuseth to work or Insists on more wages than what is hereafter mentioned. And also shall and will fill all the Corves of Coals so as the same shall come to bank more than wood full. And for every Corf of Coals that is not so, he or they shall send up Another Corf of Coals in lieu thereof, more than wood full. And for every Corf of Coals that are deemed foul to pay 1d. And every person refusing so to do shall pay 1s., which the said John Smith shall keep and detain in his hand out of the Wages of the person or persons so offending. And for the true performance hereof on the part and behalf of the said workmen they do hereby severally and respectively bind themselves separately unto the said John Smith In the sum of Ten pounds lawful money. The Barrowmen does promise and agree with the said John Smith to run 100 yards to the West from every

Shaft and 60 yards to the East for 6d. and 1d. more to be paid them for every 20 yards they shall run further. To run four Boards In every way In every Lift rank before they are to have any abatement or satisfaction made them by the said John Smith. And the said John Smith shall pay or cause to be paid once in every three weeks to the several workmen the rates or prices hereafter mentioned (that is to say) thirteen pence a score for every score of Coals they shall severally and respectively Hew and work out of Charlaw and 4d. a yard headways. And 3d. a yard for walls not less these two yards to lay upon Bank reckoning and allowing Eight pecks of Coals to each Corf the measure as is now used (viz.) four pecks heaped and four stroked * and twenty-one corfs to the score.

IN WITNESS whereof of the said several and Respective workmen have put their hands and seals the day and Year first above written.

Hewers—

RALPH FERRY.

His
ROBERT × STONES.
mark.

His
JOSEPH × HALL.
mark.

GEORGE FERRY.

His
JOHN × HUNTER.
mark.

His
JOSEPH × HOLIDAY.
mark.

RALPH ROBERT FERRY.

His
THOS. × HALL.
mark.

ROGER HOLIDAY.

WM. × & JOS. × HALL.

Witness to the signing and sealing,

ROBERT PROUD.

Hewers, each,	10s. 6d.
Barrowmen,	5s. 0d.

His
JOSEPH × HALL.
mark.

JNO. HUNTER.

JOSEPH × HOLIDAY.

THOS. × HALL.

ROGER HOLIDAY.

WM. HALL. ×

JOS. HALL. ×

ROBT. × STONES.

JOHN × POTTS.

WM. × COBURN.

Witness to the signing and sealing this 23rd November 1767,

JOSEPH ERRINGTON.

---

* Stroked over with a stick, so as to make the coal level with the rim of the pe measure.

YEARLY BOND DATED 20TH NOVEMBER 1779.

The subjoined form of Bond has been copied from a photograph of the original, in the possession of Mr George Nesham, who has kindly consented to its reproduction here:—

ARTICLES OF AGREEMENT made 20th Nov. 1779 Between Fewster Teasdale on behalf of Sir Thomas Clavering of Axwell Park Co. Durham Bart., of the one part, and us whose names are hereunto subscribed and seals affixed being Hewers of Coals and Drivers of Sled Horses on the other part. Witnesseth that all and singular us the said Hewers of Coals and Drivers of Sled Horses, do Hire and Detain ourselves, and do hereby acknowledge ourselves Hired and Detained by the acceptance of One Pound Two shillings each Hewer of Coals, and Ten shillings and sixpence each driver of Sled Horses and other considerations hereafter mentioned unto the said Sir T. C. from this day unto Nov. 22nd 1780 to Hew Work and Fill Coals and drive Sled Horses in any Pit or Pits in Andrews House Colliery in the Chapelry of Tanfield in Co. of Durham or in any Pit or Pits in Byermoor Colliery in the Parish of Whickham, Co. Durham according to the directions of the said Sir T. C. his agent or agents as he or they shall point out or direct from time to time. He the said Sir T. C. paying or causing to be paid the Rates and Prices hereafter mentioned to wit, unto the hewers of every score of Corves that shall be wrought in Andrews House Colliery the sum of 1s. 8d. for the Whole coal, 2s. for the Whole under the Top, 1s. 8d. and 1s. 6d. for the Pillars, and 8d. a yard for Headways in whole mine, and 6d. a yard for the pillars, each corf to contain and hold 24 Pecks usual coal measure and for every score of corves that shall be wrought in Byermoor Colliery aforesaid the sum of 1s. 4d. a yard Headways, the corf being kept up to the present gauge now made use of, and to give such consideration for hard and troublesome working over and above the prices above mentioned as shall be thought reasonable by the said Sir T. C.'s agents, and the Drivers of Sled Horses do agree to drive the said horses along the Sledway with well loaden corves and to drive such quantities as the Overman shall direct for the Rates and Prices of 1s. a day unto 22nd Nov. next ensuing. And the Drivers to assist the Hewers in filling the coals as usual and all and singular us the said Hewers and Drivers of Sled Horses do and each and every of us Doth further covenant and agree to begin our respective work and during the whole Term to continue the same and if any of us shall be absent from or neglect our said Work without sufficient reason for so doing We and each and every of us Agree to forfeit and pay 1s. for every such offence; if any of us the said hewers do not keep our coals clean from stones or any other refuse or do not drive our Boards in a proper manner and according to the direction of the said Sir T. C.'s agents or if any corf be not Wood full when drawn to Bank, then such

Hewer and Driver to whom it belongeth shall either send another corf in ts room, or for this and the former offence shall forfeit 1s. each and all such forfeitures shall be payable at the first Pay which shall happen after such offence or offences are committed. In Witness whereof we the said Parties have hereunto set our Hands and Seals the day and year first above written.

His
Joseph × Soulsby.
mark.

Thomas Chapman.

John Stobbs.

His
Robert × Chapman.
mark.

His
Thomas × Ramshay.
mark.

Robert Johnson.

His
James × Clark.
mark.

His
Michael × Ramshay.
mark.

His
John × Ramshay.
mark.

His
John × Soulsby.
mark.

His
George × Harding.
mark.

His
John × Stobs.
mark.

His
Robert × Stobs.
mark.

His
William × Wilson.
mark.

His
Thomas × Walker.
mark.

His
John × Murton.
mark.

His
Thomas × Murton.
mark.

His
John × Thompson.
mark.

His
Robert × Harding.
mark.

YEARLY BOND DATED 19TH MARCH 1859.

The authors are indebted to Mr Cuthbert Berkley for the following specimen of one of the last of the yearly Bonds:—

Memorandum of Agreement made this 19th day of March in the year of Our Lord One thousand eight hundred and fifty-nine, between , in the County of Durham, for and on behalf of the Owners of Colliery, in the County of Durham, on the one part, and the several other persons whose names or marks are hereunto subscribed of the other part.

The said Owners do hereby retain and hire the said several other parties hereto from the fifth day of April next ensuing until the fifth day of April which will be in the year of Our Lord One thousand eight hundred and sixty, to hew, work, fill, drive, and put Coals, and do such other work as may be necessary for carrying on the said Colliery, as they shall be required or directed to do by the said Owners, their executors, administrators, or assigns, or their viewer or agents, at the respective rates and prices, and on the terms, conditions, and stipulations, and subject to and under the penalties and forfeitures hereinafter specified and declared, that is to say,

FIRST.—The said Owners agree to pay the said parties hereby hired once a fortnight upon the usual and accustomed day the wages by them to be earned at the following rates, namely to each Hewer for every score of coals wrought out of the whole mine in the South-East Way, east of the trouble, Six shillings per score; in the whole mine in the North-West Way, Five shillings and ninepence per score; in the broken in the South-East Way, Five shillings and threepence per score; in the broken in the North-West Way, Five shillings per score; in the whole mine up the staple, Five shillings and threepence per score; and in the broken in the same way, Five shillings per score, each score to consist of Twenty tubs of like size and measure to those now in use, and to be sent to bank wood-full. In case of the seam being required to be worked on the brass parting, what is taken up below the brass parting to be carefully cast back and to be paid upon at the same rate as good coals, Fourpence per score following in to be paid in the South-East Way, also Fourpence per score for wet working.

For driving narrow work in the South-East Way: Headways, One shilling and fourpence; Holing Walls, One shilling and twopence per yard; Narrow boards, Tenpence per yard; and turning boards when narrow, eightpence per yard.

For driving narrow work in North-West Way: Headways, One shilling and twopence per yard; Holing Walls, One shilling per yard; Narrow boards, eightpence per yard; and turning boards when narrow, eightpence per yard.

For driving narrow work in the Staple Way: Headways, One shilling and twopence per yard; Holing Walls, One shilling per yard; Narrow bords, eightpence per yard; and turning boards when narrow, eightpence per yard.

The Hewers to take up Bottom Coal, coarse coal, swad, store, or other refuse, where required barrow way breadth, and the same to be cast carefully back and at one side of the board or headways. The Hewers to be paid Fourpence per score for Ramble where required as heretofore.

And to each of the parties hereby hired who are Putters, One shilling and fourpence per score of like measure as hereinbefore mentioned for putting the first average distance of eighty yards, and One penny per score additional for every twenty yards further. For putting with ponies, Tenpence per score.

And to each of the parties hereby hired who are Drivers, One shilling and fourpence per day.

And when any of the hewers are required to do shift work they shall be paid Three shillings per shift of eight hours working.

And each person for whom the said Owners shall provide a dwelling-ouse shall be supplied with a reasonable quantity of fire coal, paying the aid Owners threepence per week for leading the same.

SECOND.—The headways shall be driven not exceeding two yards wide, nd the boards four yards wide, and that the Hewers shall do the business f Drivers, and shall set on tubs, and shall do shift work when it is required, nd that the drivers shall duly drive and lead away and the putters put such a number of tubs of coals as shall be a reasonable and fair day's work, such day's work to consist of not less than twelve hours, and to commence with the drawing of the first coals, and that each hewer shall be provided with a shovel, and when required a safety-lamp and brush, by the said Owners, their executors, administrators, or assigns, or agents, for which he shall be accountable. And that the Hewers and Drivers shall, when required by the said Owners, their executors, administrators, or assigns, or agents, put with trams or act as barrow men at such rates and prices as hereinbefore mentioned, the said Owners paying the said Hewers fourpence per score furtherance; and all the parties hereby hired shall and will, in performing their respective duties, obey, abide by, and fulfil all the lawful directions and orders of them the said Owners, their executors, administrators, or assigns, or their agent or agents at the said Colliery.

THIRD.—That each person for whom a dwelling-house shall be provided as part of his wages shall keep in good repair the glass thereof or pay the said Owners for repairing of the same, it being distinctly understood and agreed that the dwelling-houses provided for any of the persons hereby hired or engaged are and form part of the wages of such persons; and on the expiration of the said hiring, or in case any of them shall quit or be legally discharged from the employment hereby agreed upon, he or they shall at the end of fourteen days thereafter quit such dwelling-house or dwelling-houses, and in case of neglect or refusal such Owners shall be at liberty, and they or any of them, their agents or servants, are hereby authorised and empowered to enter into and upon such dwelling-house or dwelling-houses, and remove and turn out of possession such workman o workmen, and all his or their families, furniture, and effects, without havin recourse to legal proceedings.

FOURTH.—The said Hewers hereby hired shall, when required (excep when prevented by sickness certified by the colliery surgeon or othe unavoidable cause), do and perform a full day's work on each and eve working day, or such quantity of work as shall be deemed equal to a day work (not exceeding eight hours), and shall not leave their work until t time appointed by the Owners or their agent, unless leave be obtained fro the person in charge, and in default thereof each of the said parties here hired and so making default shall, and for every such default, forfeit a pay to the said Owners, their executors, administrators, and assigns, t sum of Two shillings and sixpence.

FIFTH.—The said parties hereby hired shall, during all times that t pit be laid off work, continue the servants of the said Owners, subject their orders and directions, and liable to be employed by them at such wo as they shall see fit.

SIXTH.—None of the said hereby hired parties shall keep either gallowa ass, gun, or dog, and in the event of any of the said hereby hired parti whose names or marks are hereunto subscribed, wilfully or negligent disobeying the orders of the said Owners or their agents, or committing breach of any of the articles of this Agreement, then and in every su case the said Owners are hereby authorised to stop and retain out of t wages then due or next becoming due to each and every such person offending a sum not exceeding Two shillings and sixpence for every su offence, or to punish them for such misbehaviour by due course of law.

SEVENTH.—The Hewers to use their utmost endeavours in working t Coal to produce as much round merchantable coal as the nature of t mine will admit, and keep the coals free from wet (when unavoidably fill wet the tub to be chalked), also from stone, slate, or foul coal, and if a tub be sent to bank containing two quarts of stone, slate, or foul coal, should any tub be sent to bank deficient in measure, no payment to made to the hewer for hewing the same, but the hewer thereof shall not subjected to any further forfeiture or penalty on account of it.

EIGHTH.—It shall be competent for the Viewer of the said Colliery prevent the use of gunpowder, either wholly or in part, at his discretion.

PROVIDED ALWAYS that, as to such of the workmen in the said Colli as are under the age of twenty-one years respectively, these terms a conditions shall only operate as a simple contract of hiring and service, a especially that such parties shall not be subject to any of the penalties forfeitures hereby imposed, and it is hereby distinctly agreed that such the said parties as are putters, drivers, and trappers are hereby hired and with the consent of their parents or natural guardians, and that su contract is for their benefit and advantage and support, and to learn th the trade of a Coal-miner.

But it is understood and agreed that nothing herein contained sh extend or be construed to extend to alter, prejudice, lessen, or otherwise affect the legal remedies and powers which by law belong to masters and servants in their respective relations to each other, or to Magistrates having jurisdiction in case of dispute or difference betwixt them.

LASTLY.—The Hewers to be allowed one with another during the whol period of their hiring, save for one fortnight between the seventeenth da of December and the fourteenth day of January and save in case of accident happening to any of the engines or machinery placed in or upon any of the pit or pits of the said Colliery, or by reason of any accident happening in the shafts, or by reason of the mine being in an improper or unsafe state, not less work than will yield to them at the aforementioned rates the sum of Thirty shillings in each fortnight on an average of the four preceding consecutive fortnights, and that the said Owners are empowered to lay the pits off work any number of days, allowing the Hewers to have one with another not less than the aforesaid sum of Thirty shillings per fortnight on the above-mentioned average.

Signed by on behalf of the Owners.

And by

90 Hewers.
4 Hand Putters.
18 Pony Putters.
19 Drivers.

V. FORMS OF HIRING AGREEMENTS.

FIRST FORM

COLLIERY.

Fortnightly Hiring.

MEMORANDUM,—That each of us, the undersigned, has agreed to serv the owners of colliery, in the County of Northumberland; and that the owners of colliery have agreed t employ the undersigned respectively for a fortnight certain, from the dat set opposite to his signature, and so, from fortnight to fortnight, until determined by either party as hereinafter mentioned, to hew, put, or fill coals or do such other work as the owners of colliery may require for the prope working and carrying on of the said colliery, according to the prices, time of working, rules and regulations mentioned in a certain schedule of term and conditions, a copy of which said schedule is affixed in a conspicuou place in the colliery office, for the guidance of the contracting parties: an it is mutually agreed that, in the event of any party wishing to determine thi contract of hiring and service, such party may be at liberty to do so o giving a fortnight's previous notice in writing, and performing the obligations of this contract during the currency of such notice.

And it is further agreed, that if any of the undersigned shall misconduc himself during the continuance of his employment, or shall leave his employment without giving the owners of colliery th previous notice as aforesaid, he shall be liable to the laws now in force fo the regulation of Master and Servant: and if the owners of colliery shall discharge any of the undersigned without lawful cause, o without giving him a similar fortnight's notice, then the person so discharged shall be entitled to a fortnight's wages on the average of the the last preceding pay day.

And it is lastly agreed, that alterations may, by mutual agreement, b made in the prices contained in the said schedule without in other respect altering this agreement.

SECOND FORM.

Terms and Conditions between the Owners of Colliery and their Workmen.

1. The terms for hiring to be for fourteen days certain.

2. The wages to be paid once a fortnight, upon the usual and accustomed day, and up to the preceding Saturday, and to be at the following rates (that is to say): to each hewer for every score of coals wrought (hewing and filling); a score of coals consisting of twenty tubs, and the standard weight of each tub to be 8 cwt. of 112 lbs. to the cwt.; any overplus above this that may be brought to bank to be paid for at the same rate as the score price may then be. For hewing one score of coals in the whole mine, shillings and pence per score; for hewing one score of coals in the broken, shillings and pence per score.

NARROW WORK—

Winning headways, to be paid shilling and pence per yard, 6 feet wide.

Holing walls, to be paid shilling and pence per yard, 6 feet wide.

Narrow bord, to be paid shilling and pence per yard, 6 feet wide.

Narrow bord, to be paid pence per yard, 9 feet wide.

Splitting wall in broken, to be paid shilling and pence per yard, 6 feet wide.

Siding-over in broken, close wall, to be paid pence per yard, 6 feet wide.

No other narrow work to be paid in the broken. The above prices to cover all wet ramble, double working, and following in.

Putting by hand to be paid shilling and pence per score for the first 100 yards, and from 100 to 120 yards, shilling and pence per score, and so on advancing pence per score for every 20 yards. Hewers, when required to put, to be paid pence per score furtherance.

Putting with ponies to be paid pence per score for the first 130 yards, and when 30 yards are fully complete beyond the 130 yards, to be one penny per score advance, and so on advancing one penny per score for every fully completed 30 yards further, and when hewers are required to put, to be paid pence per score furtherance.

No overweight paid to, or underweight deducted from, the putters.

Hewers required to work shift work to be paid shillings and pence per shift of hours' work, and hand-putters to be paid shillings and pence per shift of eight hours' work.

Helping-up to be paid according to the age and strength of helpers-up required, but not less than one shilling per day of ten hours' work. Water leaders, ditto, but not less than shilling and pence per day of ten hours' work. Trappers and switch-keepers to be paid shilling per day of ten hours' work. Rolley drivers, to be paid one shilling and pence per day of ten hours' work. Flat lads, when required, to be paid per day of ten hours' work.

3. The owners to provide and keep at the pit a measure tub or weighing machine, and whenever any tub or tubs shall be sent to bank, suspected to be deficient in measure or weight, the coals therein shall be weighed by the heapkeeper, or other person or persons appointed for that purpose by the owners, and if found deficient, no payment shall be made for hewing and putting the same, but the hewer therof shall not be subject to any other forfeiture or penalty on that account. A person appointed by the workmen, according to the Mines Regulation Act, may attend the weighing or measuring of the tubs, and keep an account thereof. The tubs upon which the average weight is to be taken to be fixed upon by the weighman when in the shaft before they appear at bank; any average tub under the standard weight to go into the average, but not to be set out.

4. The hewers in the colliery to use their utmost endeavours in working the coal to produce as much merchantable coal as the nature of the mine will admit, and keep the same free from stone, band, slate, or foul coal; and if any tub be sent to bank containing two quarts of stones, band, slate, or foul coals, the hewer shall forfeit the sum of threepence, and for a greater quantity in proportion. The hewers to do and perform when required (except when prevented by sickness, certified by a qualified surgeon, or other sufficient unavoidable cause) a full day's work on each and every working day, or such quantity of work as shall be deemed equal to a day's work by the owners or their agent, not exceeding eight hours, and not to leave their work, until such day's work, or quantity of work, is fully performed or finished to the extent of each man's ability; and in default thereof, each of the hewers so making default, shall, for every such default, forfeit and pay to the owners the sum of 2s. 6d.

5. The headways shall be driven not exceeding 2 yards wide, and the bords 4 yards wide (except by permission of the owners or their agent), and the hewers shall do the business of the drivers, and shall set on tubs, and shall do shift work when it shall be requisite; and the pony drivers and horse drivers shall duly put, drive, and lead away such a number of tubs of coals as shall be a reasonable and fair day's work, such day's work to consist of not less than ten hours, and all persons hereby engaged shall

commence at the time appointed by the owners or their agent, each person being at his respective post at the pit, ready to commence work at such time; and each hewer shall be provided with a shovel and cracket, and maul and wedges, where required, by the said owners, for which he shall be accountable; and shall provide himself, at his own charge, with candles, picks, and drills; and the hewers, putters, and horse drivers shall, when required by the said owners or their agent, act as pony drivers, at such rates and prices as are hereinbefore mentioned; and all the parties hired, shall and will, in performing their respective duties, obey, abide by, and fulfil all the lawful directions of them, the said owners, or their agent or agents, at the said colliery. • • •

6. If the owners, or the parties hired, be desirous of adjusting the weighing machine used in the said colliery, either party shall give the other reasonable notice; such adjusting not to interrupt the working of the colliery.

7. Each workman for whom a dwelling-house or room or garden ground shall be provided by the owners, shall keep in good repair the glass in the windows thereof, or pay the owners for the repair of the same; but such dwelling-house or room or garden ground shall be occupied as and for part of the wages of the occupier, who shall not be deemed the tenant thereof, and who shall forthwith quit the same on his ceasing to be the servant of the owners; and in case he or his family, or any other person, who shall be in possession thereof, with his consent, shall refuse so to do, it shall be lawful for the owners, or their agents and servants, or any of them, to enter into and upon such dwelling-house, room, and garden ground, and to remove and turn out of possession every person occupying the same, and all furniture and effects therein, without having recourse to any legal proceedings; a reasonable quantity of fire coal to be allowed to each hewer being the occupier of a house, such hewer to pay 3d. per week for the same.

8. No workman shall be allowed to keep a pony, ass, or dog, without leave from the owners or their agent; and any workman who shall negligently or wilfully disobey the orders of the owners or their agents, or shall commit a breach of any of these terms and conditions, shall forfeit and pay, at the discretion of the owners, a sum not exceeding 2s. 6d. for every such offence; and it shall be lawful for the owners to retain the same out of any wages then due, or to become due, to the offender; or, otherwise, it shall be lawful for the owners to proceed against any workman so offending according to due course of law.

9. Every man or boy employed in the pit shall, and is hereby bound to give fourteen days' notice before leaving his employment; and it shall be lawful to withhold payment of any wages that may at that time be due to any man or boy leaving without such notice, or otherwise punished according to law, as the agent may think expedient. The owners do hereby bind themselves, under a penalty of £1, not to dismiss any man employed

in the pit without giving him fourteen days' notice, except any man has wilfully or repeatedly broken any of the foregoing rules, in which case he shall be liable to be summarily dismissed or otherwise punished according to law, as the owners or their agents may think expedient. Any of the foregoing terms or rules may at any time be altered with the consent of the contracting parties, or upon the owners giving fourteen days' notice of such alteration, and such notice shall not be considered as releasing any workman from his contract of service by the owners; but any workman not consenting to such alterations shall give the usual notice to leave his employment.

LASTLY.—Provided always as to such parties as are under the age of twenty-one years, it is understood that they shall not be subject (excepting so far as they are legally) to any of the above-mentioned penalties and forfeitures, but that nothing herein contained shall alter, prejudice, lessen, or otherwise affect the remedies and powers which by law belong to masters and servants in their respective relations to each other.

MEMORANDUM, That
have agreed to serve the
Owners of Colliery, in the said County of
and that the said Owners have agreed to employ the said
to hew, put, and fill Coals, according to the prices, rules, and regulations mentioned in a schedule on the other side, and a copy of which said schedule is to be affixed in a conspicuous place in the Colliery Office, for the guidance of the contracting parties.

And it is further agreed, that if the said
shall leave employment, without giving Fourteen days' notice,
shall forfeit all wages that may be then due to from the said Owners, or be liable to such punishment as the law may inflict.

And if the said Owners of Colliery shall discharge the undersigned without lawful cause, then the person so discharged shall be entitled to One Pound.

And it is lastly agreed, that alterations may, by mutual agreement, be made in the prices contained in the said schedule, without in other respects altering this agreement.

Dated this day of 18

THIRD FORM.

Terms and Conditions agreed upon between the Owners of Colliery and their Workmen.

1. The term of hiring to be for Fourteen days certain from any day, and not to be determined until the expiration of Fourteen days' previous notice, to be given by either party.

2. The wages to be paid once a Fortnight, upon the usual and accustomed day, and up to the preceding Saturday, and to be at the following rates (that is to say) :—

To each hewer for hewing and filling every ton of hand-filled or chingley round coals, wrought out of the seam, when working in the whole mine, prices as follows :—

The hewers to cast aside or stow away all duff coals, and nothing but the round or chingley coals to be sent to bank, without the permission of the viewer or overman, the compensation for which is included in the prices paid for hewing the round coals, as also for kirving out and stowing away the coarse bottom coal, badger, or pricking; the coals to be sent to bank free from jet, splint, foul coal, or stone.

To be paid for double working in boards per ton on round coals.

To be paid for ramble when it reaches inches per ton, and for every inches extra on round coals.

To be paid for wet working from the roof or bottom per ton on round coals.

For driving winning headways, feet wide, with two men, per yard.

Holing walls, 6 feet wide, with two men

Holing walls, 9 feet wide, with two men

Driving narrow boards, 6 feet wide, with two men, one shilling and pence per yard.

Driving narrow boards, 9 feet wide, with two men, one shilling and pence per yard.

For all narrow places per yard for every additional man beyond two.

Driving headways boards, 4 yards wide, per yard.

Siding over in the broken, when not more than 9 feet wide, and driven headways course, loose at an end, sixpence per yard; 6 feet wide, per yard.

Holing walls in the middle of the pillar, wall price.

Putters to be paid for every score of tubs, twenty to the score, whether round or small coals, where ponies are used, say—

[*Here follow putting prices.*]

It is also agreed that a proper weighing machine be placed at the mouth of each pit, for weighing the coals sent to bank, and that a person be appointed by the owners to keep an account thereof, and be paid by them. And that the hewers be allowed to appoint another person on their part, such person to be chosen from among the regular hewers of the colliery, and to be paid by the said hewers by subscription.

Drivers to be paid shillings and pence per day, of not less than ten hours, and to find their own candles.

Trappers to be paid shillings and pence per day, of not less than ten hours.

The hewers to be paid shillings and pence per shift, of not less than hours working, when requested to work shift work.

3. The Owners to provide and keep at each pit a weighing machine, and whenever any tubs sent to bank shall be suspected to be deficient in weight, the coals therein shall be weighed by the heapkeeper, or other person appointed for that purpose by the owners, and if found below 10 cwt. at the pit, and 8 cwt. at the pit, no payment shall be made for hewing and filling the same, but the hewer thereof shall not be subject to any other forfeiture or penalty on that account. The standard weight to be as follows:—

In the pit, 11 cwts.
In the pit, 9 cwts.

No person to enter the weigh-houses except the weighers and the agents of the colliery.

4. The hewers on the colliery to use their utmost endeavours in working the coal to produce as much merchantable round coal as the nature of the mine will admit, and keep the same free from stone, band, slate, or foul coal; and if any tub be sent to bank containing pounds of stone, band, slate, or foul coal, the hewer shall forfeit

For each tub in the pit, sixpence per tub.
For each tub in the pit, fourpence per tub.

The hewers to do and perform, except when prevented by accident or illness, or other unavoidable cause, when required, a full and sufficient day's work on each and every working day, or such quantity of work [illegible] shall be fairly deemed equal to a day's work of not less than hours [illegible] and not to leave their work until such day's work or quantity of work [illegible] fully performed or finished to the extent of each man's ability. When requested, the hewers to cast their duff coal and refuse to whichever side of their board the overman or deputy shall deem most convenient, and in the event of their refusing to do so, the deputy to be at liberty to lay the tramway close to one side of the board. In the longwall the hewers to cast their duff coal and refuse into the goaf between the pillars and by the side of the gateway.

5. The headways shall be driven not exceeding 7 feet wide, and the boards not exceeding 6 yards wide; and when necessary, the boards shall be driven 4 yards wide; and that the boards shall be turned out of the headways, not exceeding 3 yards wide, and to be driven 3 yards that width before being laid out; and shall be holed 3 yards wide, 3 yards from the top of the pillar; and no board to be paid for as narrow when above 3 yards wide; and the hewers shall cast aside or stow away all duff coal or refuse, they shall also separate the grey or coarse top coal from the best coals, and shall be entitled to the same remuneration as for good coals, provided such tubs as they send to bank be hand-filled and free from admixture with good round or chingley coals, duff coals, slates, stones, or other refuse, and shall do shift work when it shall be requisite; and the putters shall put away, and the drivers shall duly drive and lead away such a number of corves or tubs of coals as shall be considered a reasonable and fair day's work, such day's work to consist of not less than ten hours, and to commence from the time the putters leave bank. And each hewer shall be provided with a rake, shovel, maul, and wedges by the owners, for which he shall be accountable, and shall provide himself at his own cost with picks, drills, and candles; he shall use a rake; and the hewers shall, when requested, assist the deputies to draw timber, and to be paid   per hour; and all the parties hired shall and will, in performing their respective duties, obey, abide by, and fulfil all the lawful directions and orders of them, the said owners or their agent or agents, at the said colliery.

6. If the owners, or the parties hired, be desirous of adjusting the weighing machine or machines used on the said colliery, and of such their desire shall give to the other party a reasonable notice, an adjustment thereof shall take place in the presence of any two of the parties hired, who shall be nominated by the rest for that purpose; and whenever such machine or machines shall be found incorrect, it shall with all convenient speed be rectified, but not so as to interrupt or stop the working of the said colliery.

7. It shall be competent for the viewer of the said colliery to prevent the use of gunpowder, either wholly or in part, at his discretion; and where permitted to be used, no more gunpowder to be employed than is really necessary.

8. Each workman for whom a dwelling-house or room shall be provided by the owners shall be supplied with a reasonable quantity of fire

coal, for which he shall pay the owners threepence per week for leading the same, and shall keep in good repair the glass in the windows thereof, or pay the owners for the repairs of the same; but such dwelling-house or room shall be occupied as and for part of the wages of the occupier, who shall not be deemed the tenant thereof, and who shall forthwith quit the same on his ceasing to be the servant of the said owners; and in case he or his family, or any other person who shall be in possession thereof, with his consent, shall refuse so to do, it shall be lawful for the owners, or their agents and servants, or any of them, to enter into and upon such dwelling-house or room, and to remove and turn out of possession every person occupying the same, and all furniture and effects therein, without having recourse to any legal proceedings.

9. Every workman who shall negligently or wilfully disobey the orders of the said owners or their agents, or shall commit a breach of these terms and conditions, or shall persist in keeping dogs, asses, or poultry, shall forfeit their employment at the end of fourteen days; or otherwise it shall be lawful for the owners to proceed against every workman so offending, according to due course of law.

10. All penalties and forfeitures to be paid pursuant to these terms shall be demanded and paid on the first pay-day after they shall have been respectively incurred, and shall be thereupon deducted from the first or next following earnings or wages of the person so incurring the same, until fully paid; and if they shall not be demanded on such pay-day, and deducted as aforesaid, or if they shall be abandoned or remitted by the said owners, or their principal agent, they shall not afterwards be enforced or revived, or required to be paid.

Provided always, and it is understood and agreed that nothing herein contained shall extend or be construed to extend, to alter, prejudice, lessen, or otherwise affect the legal remedies and powers which by law belong to masters and servants in their respective relations to each other, or to magistrates having jurisdiction in case of dispute or difference between them.

VI. FORMS OF CAVILLING RULES.

FIRST FORM.

COLLIERY.

Rules for the Half-Yearly and Quarterly Cavilling.

1. That the pits be cavilled for every half-year, and that every ma have a cavil in for the pits either singly or in sets.

2. When found necessary to remove any hewer from one pit to anothe the last cavil to be the first to shift, but every man going to a pit after th cavils have been in, though he be joined to a set of men, still in referenc to the pits, he is last cavil and first to shift.

3. In every instance where it is found necessary to reduce the numb of men at any flat, the last cavil to shift first, except a man's cavil be don or stopped; then and in that case the men whose cavil have been stoppe shall be first to shift, provided there be no vacant cavil at that flat; bu should a cavil fall out at that flat aforesaid during the quarter, they, th said men, shall return back to the aforesaid flat and claim the cavil.

4. Should any men be removed from their places, owing to the sai places being too far in advance or for other reasons, the said men are t claim a cavil at that flat if there be one; if not, they are to go whe requested, and claim the first vacant cavil at such flat as they may hav been sent to, until their own goes on again, or a cavil fall out at his o their own flat; but should any man's cavil that was cavilled to such flat a the quarter be done, in such case the men (if any) who have come fro other flats must shift for the men who were cavilled to that flat at th commencement of the quarter. Should it be found necessary to remov any men from their places, the men to be removed shall receive twent four hours' notice.

5. Should any men take a bargain, they are to be one month in suc bargain before they forfeit their cavil, but should the owners or the viewer take men from coal-hewing to perform labour in any part of th colliery, they, the said men, shall not forfeit their cavils.

6. Should any flat be all "whole work" at the commencement of the quarter, and "pillar working" commence during such quarter, the first cavils to such "whole work" at the said flat shall be the first to claim the aforesaid "pillar working."

7. Any flat being "whole work" at the commencement of the quarter, and the said "whole" being done during such term or quarter, should "pillar work" or "broken" commence at this flat during such term or quarter, the men who were duly cavilled to such aforesaid "whole work" at the commencement of the quarter shall claim such "pillar work" or "broken" (subject to No. 6 Rule) the same as if they had been cavilled to it.

8. Where any flat is working "broken and whole," and a certain number of men have been cavilled to such "broken" and "whole" at the commencement of the quarter at such flat, if more men be required in the "broken" or "pillar working," the first cavils to the "whole" at such flat shall be the first shifters to the "broken"; but if men be required to shift from the "broken" to the "whole" at such aforesaid flat, the last cavils to the "broken" shall be the first shifters to the "whole," but no "whole" men shall have claim in the "broken" as long as any of the "broken" men belonging to such flat be working in the "whole."

9. Whenever a flat is all "pillar working" at the commencement of the quarter, and "whole" work commence at the said flat, the last cavils shall be first to go to the "whole"; also if necessary to reduce the number of men at a flat. All "pillar work" the last cavils are first to shift.

All other Bye-Laws relative to "pillar working" shall be considered binding if agreed on by the men at the flat at the commencement of the quarter, and witnessed by the deputy.

10. The first cavils to the night shift to be the first shifters to the day shift, and last cavils to the day shift first shifters to the night shift, the men cavilled to the night shift to remain there unless fewer are wanted. The last new-made set to work in the day shift is the first to go to the night shift if more men be required at nights.

11. That not less than four men claim a cavil at the commencement of the quarter (two men may have a cavil in if they be the last men), but should two of the set leave, the other two may claim the cavil for the remainder of the quarter, the overman having liberty to set two more men with them.

12. Should a set of men be cavilled to two bords or gateways, and have to give up one of them during the quarter, they are to claim the first or left-hand bord or gateway; but should the said bords afterwards be singled, the men who were cavilled to them to claim them.

13. Should any set of men having removed from their pit be requested to return back again, they are to go where required.

14. Should four or eight men take a bargain, and it only employ thre or six men, the odd men to claim the pit that the bargain is in.

15. In cavilling for the pits, should any cavil be missed out, owing to mistake on the part of the overman, that set of men to have a cavil in fo the pits, as also whether they be first, middle, or last cavil; if the mistak be the men's own fault, they are to go where determined at the time.

In cavilling for the places, should any cavil be missed out, owing to an mistake on the part of the overman, the cavils to be put in over again; bu should the fault be on the men's own side, they are to go where the me determine at the time, and remain at such flat during the quarter. Thi clause is intended to apply to men who have neglected to give in thei marrows' names to the overman.

16. That no rule herein contained shall be altered without the consen of both master and men.

AND LASTLY. That every man on his arrival at the shaft for th purpose of ascending or descending the said shaft shall inquire of his turn when the man (if any) preceding him shall let him know. Also every ma shall enter into the cage for the purpose of ascending or descending th shaft in his proper turn, which turn shall date from his arrival at the shaf except lads be at the shaft, then and in that case the lads shall ride first.

Signed for the Owners,

Signed for the Workmen,

Witnesses,

} Overmen.

SECOND FORM.

Some Cavilling Rules as arranged in 1886.

GENERAL.

For the purpose of cavilling it is understood that   and   are entirely distinct and separate collieries, each having its own staff a workmen, and that no changes are allowed from either one to the oth without the permission of the viewer.

The hewers in each seam are to be cavilled once each quarter to th different working places.

The putters in each seam are to be cavilled quarterly, at the same time as the hewers, to the different stations.

No hewer or putter will be allowed to exchange from any seam to another without permission from the viewer.

Rules for the Hewers' Quarterly Cavilling for Places.

WHOLE AND BROKEN.

1. That there be a sufficient number of men present to see the cavils drawn, and that some of the men count them before they are put in.

2. If any man's cavil be omitted, he shall stand last in the pit, or if a man has two cavils in, he shall claim the first one drawn.

3. The last cavil in each way to be the first to remove to any other way; if two or more men have to remove in one day, they must have cavils in for the places they are to go to, but any man can be shifted for two days to any other way if required, and should a cavil be stopped, and the men go to another place, they claim it as a cavil until their own commences again.

4. If in any panel of bords, one bord has no wall, the waggonway bord to have no wall. If in any other whole working there be no waggonway bord, then the last cavil to have no wall.

5. Each man to drive his own wall, but in case any wall has to be driven from both sides, the man belonging to the wall to have his choice of sides if both are turned away in one day; but if not turned away in one day, the men must remain in the side they turn away.

6. If any man's wall has to be driven across another man's bord, the man who drives the wall must drive across the bord also.

7. All headways, drifts, or cross-cuts to be the head of the cavil, but if the headways, drifts, or cross-cut and stenton have to be going together, the strange man must drive the stenton; if both are not going together, the men to claim the side to which they belong.

8. If a man has a narrow bord, and a wall to that narrow bord, when they are both going, he is to claim the narrow bord, and the strange man the wall.

All men that are cavilled to headways or cross-cuts are to turn away the bords they win out, if required, and should their headways or cross-cut be stopped altogether, they are to claim the last bord won out if it be vacant.

9. When a set of men are cavilled to a headways course, they shall claim all the coal coming out of it, if the mode of working be to take half a pillar off each side of the headways. If it be considered necessary to work a whole pillar off each side of such headways, they shall also claim the whole of the coal coming out, and in all cases shall claim the jud nearest the goaf.

If four men are cavilled to a headways course, and any are to remove, the last cavil must be the first to remove.

10. That each set of men drive their own jenkins and sidings-over. In each headways course in all cases the jenkin to be the head of the cavil, and then the jud. Should there be no jenkin, then a siding-over becomes the head of the cavil if yard work be paid; if no yard work be paid, the jud remains the head of the cavil. Should a jenkin, siding-over, and jud be all going together, and strange men hewing with the men belonging the coal, the latter to be the one in the jenkin, and the other in the jud, and the strange men to hew in the siding-over as required.

In case both bordways jud and headways lift are going, the bordways jud to be the head of the cavil, or should the second jenkin belonging this coal be going, the inbye one to be the head of the cavil, unless yard work be paid, then the one where yard work is paid to be the head of the cavil; but should yard work be paid in both places, that in which the highest yard price is paid to be the head of the cavil.

11. If any odd man be cavilled to the broken, and shall have a jenkin and jud going together, he shall have half of his work in each place, and if a man's marrow be off work through sickness or accident he shall have the same privilege.

12. In cavilling for ways, to start at the first cavil and follow right through. If any are to be omitted, they must be the last ones.

13. No cope shall be considered binding unless sanctioned by the overman.

14. Should any hewer by accident or sickness be prevented from following his own employment and be employed at shift work, the same shall have his own cavil when able to resume his own work.

15. If any hewer be found taking away or using picks belonging to other men, he shall be fined 5s. for each pick; the same to be paid to the man to whom the picks belong.

16. If any workman put a pick into his lamp or any other lamp he shall be fined 20s.; the same to be paid to the Local Accident Fund.

LONGWALL.

1. In all cases the winning to be the head of the cavil, and if eight men be hewing in one gateway, they must drive the winning alternately, the first cavil in each gateway to win the first jud out. In all other respects the broken rules to apply.

2. When there is a jud on each side of a gateway, and in case one of the juds be done working, and the winning to be driven, the men whose jud is done to claim the winning.

Rules for the Putters' Quarterly Cavilling for Stations.

1. The last cavil at a flat to be the first to remove to any other flat.

But if a new flat commences, the last cavil at the old one to claim the new one first.

2. The first cavil at any flat to stop at it as long as any coals are coming to that flat.

3. If there be spare putters that have no cavil, and there is a way that can do without a putter or putters, they must have cavils in with the spare putters.

4. During the course of the quarter, ponies can be changed to any flats that the overman considers necessary.

5. Should ponies be changed at any flat during the course of a shift, the putters must keep their own "goings."

6. All putters to have cavils in. If there should be any spare ones, to be the last cavils.

7. Each putter to bring his own pony out and see it into its proper stall when he is putting at his own flat; but if changed to another flat and pony, he brings the pony out he is changed to.

8. If a putter be off work, and cavils be put in at the stables, whoever gets the cavil to remain at it until the putter starts again.

THIRD FORM.

Colliery Cavilling Rules.

1. The last cavils are first to shift from any flat if required to do so.

2. The first cavils of the hewers are the first to put if required, and after one man has put, every man at that flat must have a turn before it is his turn again.

3. Any stranger coming on to the colliery must go to any flat where he is required, and last cavil to be first to shift to any flat if requested to do so, and after the stranger sees his leader put, he is next putter.

4. Any man or men a fortnight out of his cavil, at shift or bargain work, loses his cavil, unless the bargain be given up, in which case he returns to his own cavil again.

5. Any man shifted out of his own cavil a fortnight, loses his cavil, unless men are wanted at the flat he came from and men are wanted from the flat he shifted to.

6. The hewers to be cavilled double, but if single, the one to go in first

and the other in back the same as working double, otherwise two men may be set into the place.

7. Last cavil at any flat to go to the broken of their own flat first, provided there are not any men out of a cavil when any more men are wanted into the broken.

8. No exchange to be made either by hewer or putter without first acquainting the overman and getting his consent.

9. Any cavils omitted, whether hewer or putter, the same to have a cavil in for each flat, also whether they be first or last shifter from the flat.

10. Any man or men having two cavils in, he is to take the first.

11. Any man or men refusing to put, or find a putter, when it is his turn to put, to forfeit 2s. 6d. fine.

12. Last cavil from any flat, whether hewer or putter, first shifter to night shift.

13. Any man's cavil that may have to be forewon must claim outbye side first till holed, and any man's cavil stopped, he must go where requested.

14. No man or men on notice to have a cavil in, but to work their notice out in spare places.

15. If a stranger starts, and is sent along with a single man, he claims that cavil as if he had been cavilled to it at the cavilling.

PUTTERS.

Last cavil at any flat to shift to any flat where he may be wanted.

VII. JOINT-COMMITTEE RULES.

NORTHUMBERLAND STEAM COLLIERY OWNERS' AND MINERS' JOINT-COMMITTEE.*

1. That the object of the Joint-Committee shall be to discuss all questions (except such as may be termed county questions, or questions affecting the general trade) relating to matters of wages, practices of working, or any other subject which may arise from time to time at any particular colliery, and which shall be referred to the consideration of the Committee by the parties concerned. The Committee shall discuss all disputes and hear evidence, and their decision shall be final.

2. The Committee shall consist of six representatives chosen by the Miners' Union, and six representatives chosen by the Steam Collieries Defence Association, and a Chairman to be chosen annually by the two Associations, which Chairman shall have a vote.

3. At meetings of this Committee it shall be deemed that there shall be no quorum unless the Chairman and at least three members of each Association be present.

4. Each party to pay its own expenses.

5. Should any alteration of, or addition to, these Rules be desired, notice of such change shall be given at the meeting previous to its discussion.

6. If any member of the Committee is directly interested in any question under discussion, he shall abstain from voting, and a member from the opposite party shall also abstain from voting.

7. That an agenda of the cases to be heard by the Joint-Committee shall be sent out at least four clear days before each meeting, and it shall not be competent for any member to propose any other matter for discussion.

8. When both owners and miners have cases on the agenda paper, one case from each side shall be considered alternately.

---

* Rules 1 to 11 as issued by the Steam Collieries Defence Association, March 1877.

9. That if any case is referred to arbitration, and the arbitrators fail to agree as to the appointment of an umpire, the Chairman of the Joint-Committee shall make the selection. Umpi Appoi of.

10. All applications for advances or reductions in any portion of a pit shall open out the question of the prices paid to the same class of workmen throughout the whole of the pit. Prices throug the pit.

11. That before any change in hewing prices be entertained, it must be clearly shown that the average wage on which the claim is made is at least 5 per cent. above or below the county average. Averag wage.

ADDITIONAL RULES.

12.—13*th July* 1878.—That in future both the owners and the men give not less than ten clear days' notice of any application to the Joint-Committee. The notice between the two Associations to remain as at present. Notice applica

12*th May and* 14*th July* 1885.—It was decided that in future all notices should be given in writing, and either signed by an official or stamped. Notice signed stampe

13.—8*th July* 1893.—That the rule be that the three pays paid before the written notice be taken, excluding the first and last pays of the quarter, but that no evidence as to any pays be excluded. Pays' a to be ta

14.—8*th July* 1882.—Where two pits are cavilled through they are to be considered as one, and the average of the whole taken. Averag wage.

15.—10*th November* 1883.—Decided that all pays be considered to commence on the Monday, each Sunday's wage to come into the following pay. Period pays.

16.—12*th July* 1879.—The county average being taken at 4s. 9½d., it was agreed that the increase of hours, where it leads to an increase of work, should be taken at 4½d. as the maximum, but each case to depend on its own merits. It is understood that no owner can claim any reduction unless the pit's average is at least 5 per cent. above 5s. 2d. In case of any colliery claiming an advance, the county average is to be taken at 4s. 9½d., plus any advantage which may have arisen from the increase of hours. County average hewers' standa wages.

17.—10*th May* 1890.—It is agreed as a permanent settlement of the question that for the purposes of Joint-Committee the hewers' basis average wage of soft coal collieries be 4s. 7½d. for short hours and 5s. for long hours; but that in any seam when hewers are required by the manager to nick or shoot the coal in other than winning or narrow places the average wage of steam coal collieries shall obtain. Hewers average

18.—*13th November* 1880.—In future, advances and reductions to commence on the first pay commencing after the decision.

19.—*9th July* 1881.—It was agreed that in future reports and awards should state the date at which any contemplated change should take place.

20.—*18th January* 1879.—It was agreed that in future no case can be reheard until one meeting intervenes.

21.—*12th January* 1895.—The Joint-Committee recommend that agreements settling cases should be confirmed by this committee and recorded on the minutes.

22.—*26th April* 1879.—The Chairman to be re-elected annually at the meeting held on the second Saturday in May, the question of his re-election having been previously discussed at the preceding bi-monthly meeting of the Joint-Committee.

DURHAM COALOWNERS' ASSOCIATION AND DURHAM MINERS' ASSOCIATION.*

1. The Joint-Committee shall take into consideration and determine local disputes arising at any particular colliery belonging to a member of the Durham Coalowners' Association between the management and the workmen thereof (hereinafter referred to as the parties) except on county questions.

2. The Committee to be composed of six members chosen by the Durham Coalowners' Association and six members of the Durham Miners' Association, together with an impartial Chairman to be chosen annually in March (or at such other times as the office may become vacant) by the Owners' Association and the Durham County Mining Federation.

3. The Owners' and Miners' Associations shall each elect a Secretary to represent them in the transaction of the business of the Committee, and each Association shall give written notice of such appointment to the other Association, and each such Secretary shall remain in office until he shall resign or be withdrawn by the Association which elected him.

The Secretaries shall attend all meetings of the Committee and be entitled to take part in the examination of witnesses or in the discussion of any matter before the Committee, but they shall have no power to move or second any resolution or to vote on any question before the Committee, unless either Secretary be also one of the elected members of the Committee, in which case he shall in that capacity have all the rights and privileges of a member.

---

* Joint-Committee Rules, adopted 16th February 1903.

4. The Committee shall, except on county questions as hereinafter defined, have full power to settle, either by its own decision or by reference to arbitration or otherwise, all questions relating to wages, rates of payment for altered methods of working, and all questions or disputes of any other description which may arise from time to time between the parties at any particular colliery relating to matters affecting that colliery and which shall be referred to the consideration of the Committee by either of the parties concerned, and the decisions of the Committee shall be binding.

County Questions.

5. County questions are those in which any decision given by the Committee would establish a precedent affecting either the whole of the collieries in the county or several collieries, or those which have been decided by the Owners' and Miners' Associations to be county questions or which are under discussion between the Associations as affecting the county. If the hearing of a case is opposed on the ground of its being a county question, such opposition may be put forward at any time by either the Owners' or Workmen's Association, or by a member of the Committee, or by either Secretary of the Committee, and the Joint-Committee shall determine whether the contention that the case is a county question has been sustained.

Districts.

6. The collieries are to be classed into three districts with the following boundaries:—

(*a.*) The East District to comprise all those collieries which lie to the east of the Team Valley Railway.

(*b.*) The North District to comprise all those collieries which lie to the west of the Team Valley Railway and north of the Lanchester Valley Railway.

(*c.*) The Auckland District to comprise all those collieries which lie to the west of the Team Valley Railway and south of the Lanchester Valley Railway.

The owner of any colliery situated on the boundary line of any district shall have the option of choosing the district in which such colliery shall be included.

Meetings.

7. The meetings of the Joint-Committee shall be held in Newcastle-on-Tyne or such other convenient place as may be fixed by the Committee and at such dates and hours as may be fixed by the Chairman.

8. In any case brought before the Joint-Committee the owners may be represented by one or more of their agents and the workmen by any of the workmen employed upon the colliery from which the case is sent or by the checkweighman of that colliery, but it shall be competent for either side to bring such witnesses as they may deem necessary.

9. The county standard wages and hours of the various classes of workmen shall be those agreed to between the two Associations modified up or down by any change brought about by any county agreement.

10. All decisions of the Committee shall be in accordance with county awards, county agreements, county customs, and county arrangements, whether such are in writing or otherwise, and the decisions of the Committee in all cases shall be such as to bring practices, hours, or wages as nearly as may be into accord with the recognised county standards.

11. Before any application for an advance or reduction in the wages of hewers (including kirvers and tub loaders) shall be entertained it must, except as provided in Rule 12, be clearly shown that the average wage earned by the same class of persons in the seam (or portion of a seam if cavilled separately) is at least five per cent. above or below the recognised county standard rate, but there shall be excluded from the averages the earnings of any hewers who are paid an extra price in addition to the ordinary rates in consideration of their working at night under any special arrangement.

Before any application for an advance or reduction in the wages of any other classes of workmen paid by the piece shall be entertained it must be clearly shown, if the application relates to workmen employed underground and paid by the piece, that the average wage earned by the same class or classes of persons in the seam is at least five per cent. above or below the recognised county standard rate, or if the application relates to workmen at bank paid by the piece that the average wage earned by the same class or classes of persons employed at the pit is at least five per cent. above or below the recognised county standard rate.

12. If either party desires a revision of the hewing prices of the various districts comprising a seam, the Joint-Committee may make such revision or send it to arbitration although the average of the seam is not five per cent. above or below the county average, provided that in such cases the general average of the seam prevailing before the revision shall be as nearly as possible maintained.

13. The prices to be paid to hewers or other classes of workmen paid by the piece employed in new seams, or at broken, or under any other changed mode or conditions of working in any seam, for which prices are not already fixed, shall, on application, be settled by arbitration if they cannot be arranged by mutual agreement or by the Joint-Committee.

14. In cases of extension or recommencement of districts, the prices previously paid in such districts shall be paid in all extensions of the workings, except where boundaries are otherwise specifically defined.

15. On the application of the owners or workmen at any colliery, an area of and distance from goaf governing the payment of broken prices shall, if not already fixed by agreement or custom, be fixed by the Joint-Committee or arbitration.

Counter-claims.

16. All applications by one party for advances or reductions of piece-work prices shall entitle the other side to raise the question of the price, paid to the same class of workmen, throughout the whole of the pit, and all applications for advances or reductions of the datal wages of any workmen shall entitle the other side to raise the question of the datal wages paid to workmen of the same class throughout the whole of the pit, provided that, in either case, not less than seven clear days before the day appointed for hearing by Joint-Committee, a statement of any counter-claim intended to be made, together with a statement of average earnings or datal wages, as provided for in Rule 18, shall be handed to the manager, or, as the case may be, to the workmen of the colliery, and, in the case of hewing prices, specifying the names of the districts where the advances or reductions are sought. The provisions of Rule 11 shall apply to counter-claims in the same way as to original applications.

Alteration of practices.

17. In the event of any change being made by the owners of a colliery in the methods of working a mine, or any part thereof, or in the conditions under which the labour concerned is performed, no stoppage of work by the workmen shall take place, and in the event of a change of wages being awarded by the Committee or arbitration in consequence of such altered methods or conditions of working, such change shall take effect from the commencement of the altered mode or conditions of working.

Statement of average earnings.

18. No request for advance, reduction, or revision of piece-work prices, or datal wages, shall be entertained unless a statement showing the average earnings per shift, or of the datal wages, has been supplied by the Secretary of the Owners' or Workmen's side of the Committee, as the case may be, to the other Secretary at least nine clear days before the date fixed for hearing by Joint-Committee. In the case of piece-work the averages thus supplied shall be those of at least three recent consecutive pays (each given separately) actually received by the workmen, excluding the first and last pays of each quarter and the two pays immediately following the date of a decision, award, or agreement becoming operative. The averages of seams, and of the districts where the advance, reduction, or revision is asked for, shall be supplied in each case, and also the numbers and dates of the pays. The Joint-Committee in considering and determining claims for advance or reduction of piece-work prices shall be guided by the difference between the average earnings of the workmen during the pays for which averages have been supplied and the county standard rate for the class concerned, and in considering and determining claims respecting datal wages shall be guided by the difference between the datal wage of the workmen concerned and the county standard wage for that class.

Difference between wages earned and county standard.

19. In those cases where either piece-work or datal work is possible, it shall be competent for the owners to say which method of payment

shall be adopted, and if rates are not already fixed therefor to have such fixed on application to the Committee, but failing local agreement the change in the method of payment shall not take place until such application to Committee be made.

20. When both owners and workmen have cases for consideration the cases of each shall be considered alternately, and lists of cases to be considered at any meeting shall be exchanged between the two Secretaries at least fourteen days before such meeting; and it shall not be competent for the Committee to discuss any other matter than shall be specified in such lists unless the parties concerned agree to any very urgent case being heard, and both sides of the Committee concur.

21. No demand from the workmen at any colliery shall be entertained where, within the three pays supplied as per Rule 18, or, where averages are not required, within the three pays prior to the day appointed for hearing, loosing before time or restriction of work by the class of workmen seeking the change has been a general practice. No demand of either party shall be considered by the Committee if the party submitting the demand is not carrying out or has within the previous three months failed to carry out any county or local agreement or any previous decision of the Joint-Committee or any award.

22. If any objection is to be raised to the hearing of a claim or counter-claim (except as a county question), written notice stating the particulars of such objection shall be given to the manager or the workmen of the colliery, as the case may be, and such notice shall, as regards claims, be given seven clear days before the day appointed for hearing, and, as regards counter-claims, four clear days before the day appointed for hearing, but if the cause of objection arises within such seven or four days then the notice may be given at any time previous to the time appointed for hearing.

23. The Committee shall in all cases where such is possible determine the questions submitted to its consideration without calling upon the Chairman for his casting vote.

24. On any case being submitted to the Committee the parties may each state their case and may bring forward in support such evidence as they deem necessary and as the Committee may consider relevant. During the hearing of evidence there shall be no discussion or argument, the examination of witnesses being confined to putting the Committee into possession of the facts bearing on the case. When the witnesses have completed their evidence they shall retire and the members of the Committee shall then discuss and endeavour to arrive at a decision on the case. In the event of their failing to arrive at a unanimous decision any member may propose a motion for settling the matter and the Chairman shall put such motion to the Committee and it shall be determined by a vote taken by show of hands. If the votes are equal the Chairman shall

imself decide the question at issue or shall refer it to arbitration or order report as he may think fit. If the number of members present represent-ng the owners and workmen respectively is unequal, the voting shall be deemed to be equal if all the workmen's representatives present vote one way and those of the owners the other.

Date of changes taking

25. Unless otherwise arranged by mutual agreement, by the Joint-Committee, or by arbitration, all advances and reductions shall take effect rom the beginning of the pay commencing first after the date of the decision or award.

Back-mon

26. In the event of any payment of back-money being awarded, the Chairman of the Joint-Committee shall decide upon the period (not exceeding fourteen weeks prior to the day appointed for hearing by the Joint-Committee), for which such payment shall be made.

Appointm of arbitra-tors.

27. In any case referred to arbitration each party shall appoint a disinterested arbitrator within twenty-one days of the date of the reference; and if within the said twenty-one days either of the parties fail to appoint an arbitrator, the arbitrator appointed shall ask the Chairman of the Joint-Committee to authorise him to hear and determine the matter referred, and make an award which shall be binding on both parties.

Appointm of umpire.

28. If in any case referred to arbitration the arbitrators are unable to decide on the claim and fail to agree as to the appointment of an umpire, each arbitrator shall nominate not exceeding two persons, not being colliery owners, mining engineers having charge of or being interested in any colliery, or members or officials of any Colliery Owners' or Workmen's Association, and the Chairman of the Joint-Committee shall appoint a person from among those thus nominated.

Submissio reports.

29. On any case sent by the Committee for report, the persons appointed shall, if possible, submit their report to the Joint-Committee for the same district at its next meeting after the date of the reference.

Reporters unable to agree.

30. In any case referred by the Committee for report, if the persons appointed are unable to agree upon a joint-report, they shall submit separate reports showing the points on which they differ.

Rehearing

31. Cases shall not be reconsidered until after the lapse of twelve weeks from the date of their last hearing, or from the date of an award or agreement affecting the question proposed to be dealt with in the case.

VIII.—COAL MINES REGULATION ACT, 189

(59 & 60 VICT. c. 43).

THIS Act, which amended and supplemented the Act of 1887 in certai particulars, was passed while the first edition of the present work was i the press. Its provisions are given here in full, and following it will b found the further amending Acts of 1900, 1894, and 1905.

AN ACT TO AMEND THE COAL MINES REGULATION ACT, 1887.

[14*th August* 1896.]

1.—(1.) The power to propose, amend, and modify special rules fo mine under the Coal Mines Regulation Act, 1887 (in this Act referred o as the principal Act), shall include powers with respect to any of the ollowing matters:—

(*a.*) The nature and description of the lights or lamps to be used in the mine, and their custody and the mode of using and trimming them; and

(*b.*) The description of explosives to be used in the mine, the mode of using and of storing such explosives, and of making and stemming holes, and the times at which and the manner in which shots are to be fired in the mine; and

(*c.*) The number or class of persons, if any, to be permitted to remain in the mine or any part thereof whilst shots are being fired; and

(*d.*) The watering or efficient damping of the mine or any ways or places therein; and

(*e.*) Generally the precautions to be adopted for the prevention of accidents from inflammable gas and coal dust.

(2.) While any special rules made under this section are in force in any ine, any general rule contained in section 49 of the principal Act, and y special rule established under the principal Act, shall, if and so far as is inconsistent with any special rules made under this section, be sus- nded in relation to that mine.

2. Where any matter in difference is referred to arbitration under the principal Act, a majority of the workmen employed in the mine to which the arbitration relates may, on giving such security, if any, as may appear to the arbitrators or umpire sufficient to provide for the costs occasioned by such representation, appoint any person to represent the workmen, or any class of them, on the arbitration, and any person so appointed shall be entitled to attend and take part in the proceedings of the arbitration to such extent and in such manner as the arbitrators or umpire may direct, and be subject to the same liability with respect to costs so occasioned as if he were a party to the arbitration.

3. The plan required to be kept in pursuance of section 34 of the principal Act shall show the position of the workings therein mentioned with regard to the surface, and the position, extension, and direction of every known fault or dislocation of the seam with its vertical throw.

4.—(1.) For sub-sections (1) and (2) of section 38 of the principal Act shall be substituted the following sub-sections:—

"(1.) Where any mine or seam is abandoned, the person who is owner of the mine or seam at the time of its abandonment shall, within three months after the abandonment, send to a Secretary of State:

(i.) An accurate plan of the mine or seam, being either the original working plan or an accurate copy thereof made by a competent draftsman, and showing—

(*a.*) The boundaries of the workings of the mine or seam, including not only the working faces, but also all headings in advance thereof, up to the time of the abandonment;

(*b.*) The pillars of coal or other mineral remaining unworked;

(*c.*) The position, direction, and extent of every known fault or dislocation of the seam with its vertical throw;

(*d.*) The position of the workings with regard to the surface boundary;

(*e.*) The general direction and rate of dip of the strata; and

(*f.*) A statement of the depth of the shaft from the surface to the seam abandoned; and

(ii.) A section of the strata sunk through, or, if that is not reasonably practicable, a statement of the depth of the shaft with a section of the seam.

'Every such plan must be on a scale of not less than that of the Ordnance Survey of 25 inches to the mile, or on the same scale as the plan used at the mine at the time of its abandonment, and its accuracy must be certified, so far as is reasonably practicable, by surveyor or other person approved in that behalf by an inspector of mines.

"(2.) The plan and section shall be preserved under the care of the Secretary of State; but no person, except an inspector under this Act, shall be entitled without the consent of the owner of the mine or seam, or the license of a Secretary of State, to see the plan when so sent until after the expiration of ten years from the time of the abandonment: Provided that such license shall not be granted unless the Secretary of State is satisfied that the inspection of such plan is necessary in the interests of safety."

(2.) The High Court, or in Scotland the Court of Session, may, on application by or on behalf of the Secretary of State, make an order requiring any person who has, for the time being, the custody or possession of any plan or section of an abandoned mine or seam to produce it to the Secretary of State for the purpose of inspection or copying.

5.—(1.) The inspection before the commencement of work required by Rule 4 (i) contained in section 49 of the principal Act, shall extend to all working places in which work is temporarily stopped within any ventilating district in which the men have to work.

(2.) A safety-lamp shall not be used in any mine or part of a mine by any person employed therein unless it is provided by the owner of the mine, and no portion of any safety-lamp shall be removed by any person from the mine while the lamp is in ordinary use.

(3.) In Rule 12 of the general rules contained in section 49 of the principal Act, for the words, "nor shall coal or coal dust be used for tamping," shall be substituted the words, "and only clay or other non-inflammable substances shall be used for stemming, and shall be provided by the owner of the mine."

6. A Secretary of State, on being satisfied that any explosive is or is likely to become dangerous, may, by order, of which notice shall be given in such manner as he may direct, prohibit the use thereof in any mine, or in any class of mines, either absolutely or subject to conditions, and the provisions of the principal Act as to contraventions of general rules shall apply to contraventions of any such prohibitions.

7. This Act may be cited as the Coal Mines Regulation Act, 1896, and the principal Act and the Coal Mines (Check Weighers) Act, 1894, and this Act may be cited collectively as the Coal Mines Regulation Acts, 1887 to 1896.

IX. MINES (PROHIBITION OF CHILD LABOUR UNDERGROUND) ACT, 1900

(63 & 64 VICT. C. 21).

AN ACT TO PROHIBIT CHILD LABOUR UNDERGROUND IN MINES.
[30th *July* 1900.]

1.—(1.) A boy under the age of thirteen years shall not be employed in or allowed to be for the purpose of employment in any mine below ground, and accordingly sections four and five of the Coal Mines Regulation Act, 1887, and section four of the Metalliferous Mines Regulation Act, 1872, shall be read and have effect as if for the word "twelve" the word "thirteen" were substituted therein.

(2.) Nothing in this section shall apply to any boy who has been lawfully employed in any mine below ground before the passing of this Act.

2. This Act may be cited as the Mines (Prohibition of Child Labour Underground) Act, 1900.

X. COAL MINES (CHECK WEIGHER) ACT, 1894

(57 & 58 VICT. C. 52).

AN ACT TO AMEND THE PROVISIONS OF THE COAL MINES REGULATION ACT, 1887, WITH RESPECT TO CHECK WEIGHERS. [25th *Augus*
1894.]

1. If the owner, agent, or manager of any [illegible] r any person employed by or acting under the instructions of any such owner, agent, o manager, interferes with the appointment of a check weigher, or refuses t afford proper facilities for the holding of any meeting for the purpose o making such appointment, in any case in which the persons entitled t

make the appointment do not possess or are unable to obtain a suitable meeting place, or attempts, whether by threats, bribes, promises, notice of dismissal, or otherwise howsoever, to exercise improper influence in respect of such appointment, or to induce the persons entitled to appoint a check weigher, or any of them, not to reappoint a check weigher, or to vote for or against any particular person or class of persons in the appointment of a check weigher, such owner, agent, or manager shall be guilty of an offence against the Coal Mines Regulation Act, 1887.

2. This Act may be cited as the Coal Mines (Check Weigher) Act, 1894.

XI. COAL MINES (WEIGHING OF MINERALS) ACT, 1905

(5 Edw. VII. c. 9.)

An Act to amend the Provisions of the Coal Mines Regulation Act, 1887, which relate to the Weighing of Minerals. [*4th August* 1905.]

1.—(1.) The power conferred by the principal Act on the persons employed in a mine, and paid according to the weight of the mineral gotten by them, to appoint a check weigher, shall include power to appoint a deputy to act in the absence of the check weigher for reasonable cause, and the expression "check weigher" when used in the principal Act and in this Act shall include any such deputy check weigher during such absence as aforesaid.

(2.) A statutory declaration, made by the person who presided at a meeting for the purpose of appointing a check weigher or deputy check weigher, to the effect that he presided at that meeting, and that the person named in the declaration was duly appointed check weigher or deputy check weigher, as the case may be, by that meeting, shall be forthwith delivered to the owner, agent, or manager of the mine, and shall be *primâ facie* evidence of that appointment.

(3.) Where the check weigher or deputy check weigher was appointed by a majority ascertained by ballot of the persons employed in the mine, and paid according to the mineral gotten, the declaration shall so state, and if he was not so appointed, then it shall state the names of the persons by whom or on whose behalf the check weigher or deputy check weigher was appointed. Where a check weigher or deputy check weigher is appointed by such a majority as aforesaid, he shall be deemed to be appointed on behalf of all the persons employed in the mine who are entitled to appoint him.

(4.) The facilities to be afforded to a check weigher under section thirteen of the principal Act shall include provision for a check weigher of a shelter from the weather, containing the number of cubic feet requisite for two persons, a desk or table at which the check weigher may write, and a sufficient number of weights to test the weighing machine.

(5.) When a check weigher or deputy check weigher is appointed by a majority ascertained by ballot of the persons employed in the mine, and paid according to the mineral gotten, he shall not be removed by the persons employed in the mine except by a majority ascertained by ballot of the persons employed and paid as aforesaid at the time of the removal.

2.—(1.) For the purposes of the principal Act and of this Act the persons who are entitled under section thirteen of the principal Act to appoint a check weigher, and from whom he is entitled under section fourteen of the principal Act to recover his wages or recompense, shall be deemed to include not only the persons in charge of the working places, but also all holers, fillers, trammers, and other persons who are paid according to the weight of the mineral gotten.

(2.) Where there are persons employed in a mine who are employed by a contractor who is himself paid according to weight of mineral gotten, such persons, if they are either in charge of the working places or are holers, fillers, trammers, or brushers, shall, notwithstanding that they are paid by the contractor and otherwise than in accordance with the weight of mineral gotten, be deemed to be included among those who are entitled to appoint a check weigher, and from whom he is entitled as aforesaid to recover wages or recompense, but the proportion of such wages or recompense recoverable in respect of such persons shall be paid by the contractor who employs them, and recoverable by the check weigher from him alone.

(3.) The wages or recompense which a check weigher may recover under section fourteen of the principal Act shall include expenses properly incurred by him in carrying out his work under the principal Act.

3. All persons who are entitled by the principal Act or this Act to appoint a check weigher or deputy check weigher shall have due notice given to them of the intention to appoint a check weigher or deputy check

weigher, by a notice posted at the pithead or otherwise specifying the tim and place of the meeting, and have the same facilities given to each them for the purpose of recording their votes either by ballot or otherwis in such appointment.

4.—(1.) This Act shall be construed as one with the principal Act.

(2.) This Act may be cited as the Coal Mines (Weighing of Minerals Act, 1905, and the Coal Mines Regulation Acts, 1887 to 1896, and th Coal Mines Regulation Act (1887) Amendment Act, 1903, and this Ac may be cited collectively as the Coal Mines Regulation Acts, 1887 to 1905

XII.—EXPLOSIVES ORDER.

THE following is a summary* of the chief provisions of the Order now in force:—

The Order contains a list of explosives which have passed the Government test—called "Permitted Explosives."

The Order applies specially to two classes of seams in coal mines:—Class 1—Seams in which inflammable gas has been found within the previous three months in such quantity as to be indicative of danger; and Class 2—Seams which are not naturally wet throughout.

In these seams the use of all explosives except the permitted explosives is prohibited—in Class 1 throughout the seam—in Class 2 in all roads and in all dry and dusty places: and the use even of the permitted explosives is subject to the following conditions:—

(*a.*) The charge to be placed in a properly drilled shot hole with sufficient stemming.

(*b.*) The charge to be fired by an efficient electrical apparatus or other means equally safe.

(*c.*) The charge to be fired by a competent person appointed in writing by the owner, agent, or manager, not being a person whose wages depend on the amount of mineral to be gotten.

The use of permitted explosives in main haulage roads and main intakes is subject to the further condition that every part of the roof, floor, and sides within a distance of 20 yards from the place where the shot is fired must, unless naturally wet, be thoroughly watered at the time of firing.

In seams not included in the two classes just mentioned, the Order applies only to the main haulage roads and main intakes: in them an alternative is allowed:—If explosives not in the permitted list are used, the workmen, with certain exceptions, must be withdrawn from the mine when the shots are fired; but if permitted explosives are used, the workmen need not be withdrawn, provided the roof, floor, and sides within 20 yards from the place where the shot is fired must, unless naturally wet, be thoroughly watered at the time of firing.

---

* As appended to the official Abstract of the Coal Mines Regulation Acts, issued by authority of the Secretary of State.

The list of permitted explosives may be seen in the copies of the Order, which are supplied by the Home Office to the mine owners. To each explosive certain further conditions are attached, which must be carefully observed; and the provisions of the Order are not in substitution for those in the Coal Mines Regulation Acts or Rules, or of any special rules of the mine, but are in addition to them.

GLOSSARY OF MINING TERMS

USED IN THIS BOOK.

Backbye Work.—Work done between the shaft and the working face, in contradistinction to face work, or work done at the face.

Bait Time.—Meal time underground. A term in use in Northumberland and Durham; in other districts "Snap" or "Whiff."

Balks.—(1.) Irregular shaped masses of stone intruding into a coal seam, or bulgings out of the stone roof into the seam. (2.) Big pieces of timber for supporting the roof.

Bank.—The surface-land immediately surrounding a pit's mouth.

Bannocking.—See *Kirving.*

Bat, Batt, *or* **Bass.**—A compact black bituminous shale which splits into fine laminæ. Is often interstratified in layers with coal.

Bearing.—See *Kirving.*

Bind.—A local term for shale.

Black Stone.—A carbonaceous shale.

Blue Metal.—A local term for shale possessing a bluish colour.

Blue Stone.—An argillaceous rock of a more amorphous and less shaley nature than blue metal.

Bolt Holes.—The narrow roads connecting a "side of work" with the other workings of the mine in thick coal workings. A term peculiar to the "Wide" or "Square" system of working.

Bondminder, *or* **Rolleywayman,** *or* **Roadman.**—A man in charge of the rolleyway.

Bord (Narrow).—A road less than 4 yards in width driven in a seam in a direction at right angles to the main cleavage planes of the coal seam, usually about east and west in the Newcastle coalfield.

Bord Room.—The space excavated in driving a bord. The term is used in connection with the "ridding" of the fallen stone in old bords when driving roads across them in pillar working; thus, "ridding across the old bord room."

Bord (Wide).—A road in same direction as in Narrow Bord, but four or more yards wide.

Bordways Course.—The direction at right angles to the main cleavage planes. In some mining districts it is termed "On face."

Brattice.—A partition for purposes of ventilation.

Broken.—A district of coal pillars in process of removal—so called in contradistinction to the first working of a seam by bord and wall, or working in the "whole." See *Whole Working.*

Brushing, Brushers.—Stonework; shooting top or bottom stone to make height. "Brushers" are stonemen. See *Ridding* and *Ridders.*

Buttocker.—One who breaks down the coal which has been undercut by the "holers." A "getter."

Butty.—An underground contractor. See *Small Butty* and *Charter Master.*

Canch, *or* **Caunche.**—A thickness of stone requiring to be removed to make height, or to improve the gradient of a road. If above a seam, it is termed a "*Top Canch*"; if below, a "*Bottom Canch.*"

Carting.—Conveying coal in small tubs along low roads to the big trams on a main road.

Cauldron Bottoms.—The fossil remains—or, more correctly speaking, the "casts"—of the trunks of sigillariæ, which have remained vertical above or below the seam.

Cavils.—Lots drawn by the hewers each quarter-year to determine their working places.

Charter Master.—A contractor who engages to work a seam, or sometimes a small colliery, at a tonnage price for the owner or owners, the charter master finding and paying the underground labour. (Staffordshire.)

Chocks.—Pieces of hard wood about 6 inches square by 1 foot 6 inches long, built crosswise two and two to form supports for the roof.

Cleat, *or* **Cleavage.**—The smooth facings or partings which run through a seam of coal in two directions, at right angles to each other, one set (the bordways cleat) being usually much more pronounced than the other. Some seams are without it.

Clift.—Local term for shale.

Clod.—A soft stone immediately above a seam.

Clunch.—Tough clay or marl, fireclay.

Coaly Rashings.—Soft dark shale, in small pieces, containing much carbonaceous matter.

Cogs.—A pillar of chocks (see *Chocks*) with the centre space stowed with stone or rubbish.

Cope, *or* **Coup.**—An exchange of working places between hewers.

Cropping Coal.—The leaving of a small thickness of coal at the bottom of the seam in a working place, usually in order to keep back water. The coal so left is termed "*Cropped Coal.*"

Cross-cut.—A road driven in a direction diagonal to the cleavage planes of the coal seam.

Cross-heading, *or* **Cross-gateway.**—A road kept through goaf, and cutting off the gateways at right angles or diagonally.

Crowntree.—A piece of timber set on props to support the roof.

Dead Work.—Excavations other than coal work.

Deputy, *or* **Deputy Overman.**—An under official acting under the overman, and whose duty it is to make the daily examinations of the workings in the district in which he is stationed, to set timber, lay "way," and in some cases fire the shots for the men.

Dillies, *or* **Ginneys.**—Short self-acting inclines, where one or two tubs at a time are run.

Dirt.—A soft or shaley stone band in a coal seam.

Double Timber.—A balk and two props of big timber properly dressed and notched.

Drift.—Any road cut through strata.

Drive, To.—To cut a road through strata.

Dyke.—A "wall" of igneous rock passing through strata, with or without accompanying dislocation of the strata.

Face, *or* **Coal Face.**—The place where the hewers are working.

Fast.—A road driven in a seam with the solid coal at each side is termed "fast." "Fast at an end," or "fast at one side," implies that one side is solid coal, and the other open to the goaf or some previous excavation.

Feeder.—A runner of water.

Fiery.—Applied to a mine containing explosive gas in dangerous proportions.

Fireman.—A Midland and South Wales equivalent to a "*deputy*" (which see) with this exception, that a fireman does not set timber or lay way.

First Working.—See *Whole Working*.

Flat.—The siding or station laid with two or more lines of railway, to which the putters bring the full tubs from the working face, and where they get the empty tubs to take back. The area of working places, from which coal is brought to the same station, is also called a "flat." In South Wales a plank supported by two or more props. "*Putter's Flat*," in Northumberland and Durham, a siding to which the putters bring the loaded tubs from the face.

Following Stone.—Roof stone which falls on the removal of the seam.

Gateway.—A road kept through goaf in longwall working.

Gears, *or* **Pair of Gears.**—Two props and a plank, the plank being supported by the props at either end.

Ginneys.—See *Dillies*.

Girdle.—A thin bed or band of stone. A roof is described as a post roof with metal girdles, or a metal roof with post girdles, according as the post or the metal predominates.

Goaf, *or* **Gob.**—The part of a mine from which the coal seam has been taken, and the roof allowed to fall, or the space stowed with stone and rubbish.

Going Headways, *or* **Going Bord.**—A headways or bord laid with rails, and used for conveying coal tubs to and from the face.

Grey Metal.—Shale of a greyish colour.

Hade.—The slope or inclination of a fault—that is, its deviation from the vertical.

Heading.—See *Winning Headways.*

Headways.—A road, usually 9 feet wide, in a direction parallel to the main cleavage planes of the coal seam, which direction is called "*Headways Course,*" and is generally about north and south in the Newcastle coalfield. It is termed "*On end*" in other districts.

Heaving.—The rising of the thill (or floor) of a seam, where the coal has been removed.

Hitch.—Local term for a fault of no great throw.

Hole.—The act of making an opening from one road into an adjacent one.

Holing.—An opening or road connecting one part of the mine with another part. A connection made between two or more roads underground. See *Kirving.*

Inbye.—Towards the working face.

Instroke.—The right to take coal from a royalty to the surface by a shaft in an adjoining royalty. A rent is usually charged for this privilege.

Intake.—The road by which the fresh air is conducted to the working face.

Jenkin.—A road cut in a pillar of coal in a bordways direction—that is, at right angles to the main cleavage planes.

Jig, *or* **Jig Brow.**—A self-acting incline, usually made on the full rise of the seam. In longwall workings to the rise, the gateways are, in highly inclined seams, the "jigs."

Jud.—(1.) A portion of the working face loosened by "kirving" underneath, and "nicking" up one side. The operation of kirving and nicking is spoken of as "*Making a Jud.*" (2.) The term jud is also applied to a working place, usually 6 to 8 yards wide, driven in a pillar of coal. When a jud has been driven the distance required, the timber and rails are removed, and this is termed "*Drawing a Jud.*"

Keeker.—An official who superintends the screening and cleaning of the coal.

Kenner.—See *Loose.*

Kirving, *or* **Holing,** *or* **Bearing.**—A horizontal cutting made into a seam, preparatory to breaking down the whole height of coal. Usually this is made in the bottom of the seam, but sometimes in a band of stone or "dirt," if the seam contains such; sometimes in a fireclay underlying a seam; and sometimes in a soft stone above the seam. (The last method is called in Staffordshire "*Bannocking.*")

Kist.—The wooden box or chest in which the deputy keeps his tools. The chest is always placed at the flat or lamp station, and this spot is often referred to by the expression, "at the kist."

Leader.—The earthy deposit in the line of a fault, which is followed in searching for the coal seam.

Lift.—Any working place about 6 or 8 yards wide driven in a pillar.

Loose.—Applied to a working place to denote that it is open at both sides—that is, that the coal has been previously removed at both sides. "Loose at an end," or "loose at one side," denotes that the coal has been already worked at one side. The end of a shift or of the day's work is spoken of as "*Loosing time,*" or "*Loose,*" or "*Kenner*"; and when the workmen leave, the pit is said to be "*Loosed out.*"

Marrow.—A partner.

Metal.—See *Blue Metal* and *Grey Metal.*

Mothergate.—The main road of a district in longwall working.

Narrow Work.—All work for which a price per yard of length driven is paid, and which therefore must be measured.

Nicking.—A vertical cutting or shearing up one side of a face of coal.

Nip-out.—The disappearance of a coal seam by the thickening of the adjoining strata, which take its place.

Nippers.—Boys who attach the "clips" to the tubs and rope in endless rope haulage.

Nogs.—Timber in places above the coal. See *Chocks.*

Nook.—The corner of a working place made by the face with one side.

Outbye.—Towards the shaft.

Outstroke Rent.—The rent which the owner of a royalty receives on coal brought into his royalty from adjacent properties.

Packwalls.—Pillars of stone, built to support the superincumbent strata.

Panel.—Used in two senses. (1.) A division or district in bord and pillar working. (2.) A thick bed of stone—for example, "A thick panel of strong white post."

Parting.—A layer of dirt or foreign material in a coal seam.

Picture.—A screen to keep off falling water from men at work.

Pike Man.—A Staffordshire term for a coal hewer.

Place.—The portion of coal face allotted to a hewer is spoken of as his "working place," or simply "place."

Plank.—See *Crown Tree.*

Plates.—Metal rails 4 feet long.

Post.—Local term for sandstone. Post stone may be "strong," "framey," "short," or "broken."

Ramble.—Stone of little coherency above a seam, which falls readily on the removal of the coal. See *Following Stone.*

Repairers.—Men who do stone work and repair the roads.

Ridding.—Clearing away fallen stone and *débris.*

Riding.—Ascending or descending the shaft in the cage.

Rippers.—Stonemen.

Ripping.—Removing stone from its natural position above the seam.

Rock.—Sandstone. See *Post.*

Rock Binds.—Sandy shale or shaley sandstone.

Rolleyway.—A main haulage road.

Royalty.—An area of coal owned as a distinct property, the rent paid to the proprietor thereof for working the coal being called "*Royalty Rent.*" The royalty rent is also in common parlance often termed "royalty" simply.

Sagre, *or* **Seggar.**—A local term for fireclay, often forming the floor (or thill) of coal seams.

Scale of Air.—A small quantity of air escaping (or sometimes allowed to pass) at a door or stopping, or brattice.

Scallop, To.—To hew coal without kirving or nicking, or shot-firing.

Shaft.—A space made by the side of the rolleyway for a tram to stand at the bottom of a stall road where the coal is filled into it by "carting." (South Wales.)

Shaft Pillars.—The coal left for the support of the shafts.

Sheth.—An old term denoting a district of about eight or nine adjacent bords. Thus, a "*Sheth of Bords,*" or a "*Sheth of Pillars.*"

Shift.—The duration of a day's work.

Side Laning.—Taking off side coal to widen out a place in a "side of work." (Staffordshire.)

Side of Work.—An expression used to denote the face in the "wide" or "square" system of working. (Staffordshire.)

Siding-Over.—A short road driven in a pillar in a headways direction.

Skips.—Skirtings for widening out a coal road. (South Wales.)

Skirting.—A road driven next a fall of stone, or next an old fallen place.

Slab.—See *Crowntree.*

Small Butty.—A contractor who engages to work a certain part of a seam—usually reckoned as a certain width of face—at a tonnage price, the contractor finding and paying the labour necessary to get and deliver the coal at the bottom of the gate-road. (Staffordshire.)

Snapping.—See *Bait Time.* (Staffordshire.)

Splint.—Coarse coal.

Split.—A division of the air current.

Sprag.—A short prop of timber used for supporting the upper part of a seam during or after kirving; also as a brake to coal tubs, being inserted between the wheel spokes.

Staple.—An underground shaft.

Stenton.—A narrow place or holing made between a pair of winning roads for the purpose of ventilation.

Stint Work.—Bargain work.

Stone.—Ironstone. (Staffordshire.)

Stook.—A block of coal a few yards square left to support the roof in certain stages of pillar working.

Stopping.—A wall built to prevent the passage of air.

Stowing.—Filling a place with stone or *débris.*

Stythe.—Poisonous gas, generally carbonic acid (CO_2).

Swally, *or* **Swelly.**—A trough, or synclinal, in a coal seam.

Taking, *or* **Take.**—See *Royalty.*

Thill.—The floor of a seam.

Thirling.—See *Stenton.*

Token.—A piece of leather or metal stamped with the hewer's putter's number or distinctive mark, and fastened to the tub he is filli or putting.

Topholes.—Places going to the full rise.

Trammers, *or* **Putters,** *or* **Hauliers.**—Big lads who convey t coal tubs to and from the working places.

Tree.—A local term for a prop.

Trouble.—Local term for a "fault," or geological disturbance int rupting the continuity of a seam.

Tumble Up.—Room by the side of the way for the empty tram be turned over so that the full tram can pass it. (South Wales.)

Under Looker.—A Midland equivalent to the North Country fore-overman.

Under the Top.—A road in which a layer of coal is left standing to form the roof is said to be "under the top."

Viewer.—The old term for a Colliery Manager.

Wailing.—Picking stones and dirt from amongst coals.

Wall.—A road, usually 6 to 8 feet wide, between two adjacent bords, at right angles to them. The solid coal between two bords is also called a "wall." A "*Half-pillar wall*," or "*Split wall*," is a road driven across the middle of a pillar on headways course.

Warrant.—Kind of fireclay.

Wash-out.—The erosion of an appreciable extent of a coal seam by aqueous agency.

Waste.—(1.) The portion of a mine occupied by the return airways. (2.) Also used to denote the spaces between the packwalls in the gob of longwall working.

Whole Working.—The first working of a seam, which divides it into pillars.

Winning Headways.—A headway driven in advance to win out room for the bords. Any leading drift is termed a "*Winning.*"

Yard Price.—Various prices per yard driven (in addition to the tonnage prices) paid for roads of certain widths, and driven in certain directions.

INDEX.

ACKERMAN, Mr A. S. E., on cost with coal-cutters, 130
Acomb colliery, cost of working, 22
Adit or day-drift, 2
Agreement to drive a stone drift, form of, 89
Air drilling machines driven by compressed, 92
Air-boxes and air-tubes, 143
Air-crossings and regulators, 8
Air-crossings and stoppings, 143
Air-crossings, stonework in connection with, 86
Alternating current electricity applied to coal-cutting, 118
Altofts colliery, coal-cutting at, 124
America, machine coal-cutting in, 118
Appliances for breaking down coal and stone, 112
"Ascensional" ventilation, 170
Atkinson, Mr J. J., 8
Atmospheric engine, Newcomen's, 3

BACKBYE work, 401
Back-overman, 66
Bainbridge, Mr Emerson, on co-operation, 30
Bainbridge, Mr Emerson, on the education of mining engineers, 51
Bait time, 401
Balks, 401
Bank, 401
Banksmen, 96
Bannocking, 405
Bargain work, miscellaneous, 94
Barnsley bed, single-stall working, 233
Barnsley bed, worked by longwall, 208
Barriers, 9, 13
Barriers between panels, removal of, 173 189
Barriers, removal of, at Eppleton colliery 190
Bass, 401
Bat, 401
Batey, Mr J. W., on coal conveyors, 134
Bearing, 405
Bell pits, 1
Benefit societies, 47
Bidder, Mr G. P., on the profits of coal pits, 29
Bill, overman's wage, 99
Bind, 401
Binding money, 33
Birtley colliery, a view at, 11
Blackboy colliery, cost of working, 22
Blackett's conveyor, 134
Blacksmith's wage, 1763, 37
Black stone, 401
Blue metal, 401
Blue stone, 401
Boll *or* bowl, the, [illegible]3
Bolt holes, 401
Bond, pitman's yearly, 1706, 33
Bondminder, 401
Bonds, yearly, of various dates, 360, 36[illegible]

Book of Boldon, 2
Bord, 3, 401
Bord and pillar method of working, 138
Bord and pillar, working by, 150
Bord and pillar working, practical example in, 168
Bord and pillar and longwall, labour required in, 140
Bord and pillar and modified longwall, comparative cost of, 307
Bordrooms, ridding through, 88
Bordways course, 401
Bowl, *or* boll, 33
Bowley, Mr A. L., on changes in wages, 43
Boyd, Mr E. F., on the knowledge requisite in mining profession, 49
Boys employed underground, age of, 97
Brandling, Mr, explains method of regulating the vend, 25
Brandon High colliery, cost of working, 20
Brass Thill and Five-quarter seams worked together, 239
Brattice, 402
Bratticing, special case of face, 141
Bratticing winning places, 139
Brick brattice, cost of, 142
British coal trade, age of, 1
Brockwell seam, Towneley colliery, pillar working, 179
Broken price, 78
Broken working, 402
Brown, Mr T. Forster, on the colliery manager, 49
Brushing, 402
Buddle, Mr John, on "creep," 5
Buddle, Mr John, on the average profit of collieries, 28
Buildings, subsidence of, 212
Busty seam, pillar working in, 178
Busty seam worked in two sections, 237
Buttocker, 402
Butty, 402
Byermoor colliery, method of working pillars at, 178
Byermoor colliery wage-bill, 1770, 36
Byker colliery, report on, 1746, 10

CANCH, 84, 402
Carter, Mr Joseph, on working two seams when near together, 240
Carting, 402
Cauldron bottoms, 402
Caunche, 402
Cavilling, 77
Cavilling rules, forms of, 377, 379, 382
Cavils, 402
Celynen colliery, longwall *v.* double-stall 233
Chain coal-cutters, 114
Chalder, *or* chaldron, 24
Champion coal-cutter, 114, 121, 123
Charter master, 402
Chartershaugh, removal of pillars at, 10
Check viewer, 58
Chocks, 402
Clark, Mr W., on Jeffrey chain machine, 130
Clark & Steavenson's coal-cutter, 115
Cleat, 402
Cleavage, 402
Cleavage of coal, 3, 163, 164
Clift, 402
Clod, 402
Clunch, 402
Coal-cutting by machinery, advantages of, 132
Coal-cutting machines, 113
Coal-cutting machines, report of N.E. Institute on, 132
Coal-drawing, days and hours of, 74
Coal face, 403
Coal left in pillars, percentage of, 9, 195
Coal Mines Regulation Act, 1887, 312
Coal Mines Regulation Act, 1896, 392
Coal Mines (Check Weigher) Act, 1894, 395
Coal Mines (Weighing of Minerals) Act, 1905, 396
Coal trade, age of British, 1
Coaly rashings, 402
Cogs, 402
Colliery manager and the law, 293
Colliery managers' certificates, examination for, 50

"Compleat Collier," 9, 35
Conciliation Act, 1896, 300, 303
Conditions of working in different districts compared, 261, 286
Consideration, 79, 102
Conspiracy and Protection of Property Act, 1875, 300, 304.
Conveyors, 134
Co-operative stores, beneficial effect of, 44
Co-operative stores, expenditure at, 45
Cope, 402
Copley Bent colliery, 1780, 11
Corf, 35
Cost of an air crossing, 146
Cost of brick brattice, 142
Cost of hewing in longwall, 219
Cost of working by double-stall and bord and pillar compared, 227, 228, 231, 232
Cost of working by longwall, 220, 307
Cost of working coal, 15
Cost of working Hutton seam, Eppleton colliery, 191
Cost of working modified longwall, 309
Cost of working pillars, 309
Cost sheets, forms of, 102
County average wage, 80
Coup, 402
Coursing the air, 168
Cranston's rock drill, 92
Creep, 5, 161
Cropping coal, 402
Cross-cut, 402
Cross-cut, mode of working coal in a, 164
Cross-gateway, 403
Cross-heading, 403
Cross-headings, mode of forming, 214
Crowntree, 403
Curved roads, method of driving, 157

DALE, Sir David, on changes in value of commodities, 43
Dale, Sir David, on claims of labour, 29
Damage to surface, 9, 136, 212
Datallers, 95
Davies, Mr Morgan W., 234
Davy, Sir Humphrey, date of his invention of safety-lamp, 3
Day-drift, 2[illegible]
Dead work, 403
Deductions from miners' wages, 42
Delaval papers, 38
Depth of coal seams in relation to top pressure, 160
Deputies, 67
Deputy overman, 403
Diamond coal-cutter, 114, 126, 127
Dillies, 403
Direction of main roads, 156
Dirt, 403
Districts, different, conditions and results of working in, 261
Dominion No. 1 Colliery, Canada, coal-cutting at, 120
Double-stall, advantages and disadvantages of, 232
Double-stall system in South Wales, 233, 236
Double-stall working in a thin seam, 235
Double-stall working in North of England, 222
Double timber, 403
Drift, 403
Drifts in stone, agreement for driving, 89
Drilling gear, 110
Drilling machine, hand, 111
Dunn, Mr Matthias, on old system o mine ventilation, 8
Dunn, Mr Matthias, on the working o pillars, 10
Durham coking colliery, results at, 268
Durham (East), gas and house coal colliery results at, 272
Durham gas-coal colliery, results at, 270
Duties of colliery manager, 56, 293
Duties of H.M.'s inspectors, 295
Dyke, 403

EARNINGS of a miner's family, 41
Easton and Dunn, Report by Mess 13
Electricity, special rules for use of, 3[illegible]

Elemore colliery, double-stall working at, 229
Elemore colliery, experiments with stub-and-feather, 111
Elliot, Sir George, his scheme for a national coal trust, 28
Elliot, Sir George, on effects of working overlying or underlying seams, 238
Elliot, Sir George, on the profession of the mining engineer, 48
Employers' Liability Act, 1880, 300
Employers and Workmen Act, 1875, 300, 302-304
Engineer, *or* foreman enginewright, 70
Engineman's wage, 1760, 36
Engines at collieries, first use of steam, 3
Eppleton colliery, double-stall working at, 222
Eppleton colliery, method of working pillars at, 184
Expenditure of miners, 44

FACE, 403
Face, manner of getting the coal at the, 162-167
Fallowfield colliery, 1828, 12
Fast, 403
Fatal Accidents Acts, 300, 304
Faults, proving, 152
Feeder, 403
Fiery, 403
Fiery seam, working of, 100 years ago, 9
Fireman, 403
First working, 403
Firth's coal-cutting machine, 118
Five-quarter and Brass Thill seams, working of, 239
Flat, 403
Flat, putters', 81
Following up the "whole" with the "broken," 169
Following stone, 403
Ford colliery, Northumberland, 1757, 11
Foreman enginewright's daily report, 71
Fracture of strata by subsidence, 136

GADERICK colliery wage bill, 1707, 34
Galloway, Mr R. L., on "creep," 6
Garesfield colliery, method of working pillars at, 183
Gassy collieries one hundred years ago, 6
Gateway, 403
Gateways, distance between, 198
Gears, 403
General pay bill, 102
Gillott & Copley's coal-cutting machine, 114, 124
Ginneys, 403
Girdle, 404
Glenclelland colliery, coal-cutting at, [illegible]
Glossary of mining terms, 401
Goaf, 404
Gob, 404
Going bord, 404
Going headways, 404
Gold, appreciation of, 43
Gradient of main roads, 154
Graham, Mr Edward, jun., on double-stall working, 235
Graigola seam, South Wales, worked by double-stall, 236
Graphical forms of cost sheets, 102
Greenwell, Mr G. C., on removal of pillars, 10
Greenwell, Mr G. C., on working thin seams, 197, 221
Grey metal, 404
"Grip," a, 31

HADE, 404
Hall v. *Hopwood*, 298
Halmote Court, Co. Durham, 9
Hand putter at work, 82
Hand-drilling machine, 111
Harrison's coal-cutting machines, 115
Haseltine, Mr R. M., on coal-cutting, 118, 127
Hauliers, 407
Headways, 404

Heapkeeper, *or* keeker, 71
Heapkeeper's daily report, 75
Heaving, 404
Hewers' hours and wages, 76
Hewers' wages formerly, 35
High Main seam, Killingworth colliery, pillar working, 180
Hill system of working, 259
Hiring agreement, forms of, 368, 369, 373
Hiring, terms of, 32
Hitch, 404
Hole, 404
Holers, getters, and fillers, 199
Holing, 404, 405
Holmes, Mr J. H. H., on "creep," 6; on pillar working, 9
Hours of work formerly, 32
House accommodation for miners, 46
Hunter, Mr George, on pillar working, 193
Hurd bar coal-cutting machines, 114, 127
Hutton seam, Eppleton colliery, pillar working, 136
Hutton seam, Murton colliery, pillar working, 184

INBYE, 404
Inclined drifts, 91
Income of a miner, 41, 44
Ingersoll-Sergeant coal-cutter, 114, 119
Ingersoll radial machine, 120
Inspectors, H.M.'s, duties of, 295
Instroke, 404
Intake, 404
Intake air, regulation of, 173
Interest on invested capital, 27
Irregularity of coal seams, 151

JEFFREY coal-cutting machines, 114, 128
Jenkin, 191, 404
Jig brow, 404
Johnson & Wood, report by Messrs, 13
Joint-Committee rules for Durham, 386
Joint-Committee rules for Northumberland 384
Joint-committees, action of, 80
Jordan, Mr J. J., on working two seams o coal lying near together, 239
Jud, 404
Jud, timbering of a, 185

KEEKER, *or* heapkeeker, 71, 405
Keel-load, 24
Kendall, Mr J. D., on miss-fires, 165
Kenner, 405
Kenny, Mr P. D., on purchasing power wages, 43
Kidd, Mr Benjamin, on the distribution wealth, 29
Killingworth colliery, method of workin pillars at, 180, 181
Kirkup, Mr F. O., on Blackett's conveyo 124
Kirving, 163, 405
Kist, 405

LABOUR, arrangement of, in longw system, 199
Labour, former conditions of, 31
Labour in collieries, present conditions 43
Labour, proportion of different classes 40
Labour, superintendence of, 64
Laid-out tubs, 80
Large pillars, method of working at Ep ton colliery, 19[illegible]
Law, colliery manager and the, 293
Leader, 405
Leases of coal-mines, 58
Levellings, 63
Lidgett colliery, coal-cutting at, 115

Lift, 405
Lishman, Mr Thomas, on air-crossings, 145
Little Hardy coal-cutter, 114, 122
Living, cost of, amongst miners, 45
Longbenton colliery, cost of working, 18
Longwall, Derbyshire method, 207
Longwall in South Wales, 255
Longwall method of working, advantages of, 138
Longwall, modified, in South Staffordshire, 246
Longwall system, chief points to be considered, 220
Longwall system, detailed description of, at a North of England colliery, 211
Longwall working at Cannock Chase, 208
Longwall, "working home," 197
Longwall working in thick seams, 206, 208, 211
Longwall working in Yorkshire, 208
Loose, 405
Low Main seam, Castle Eden colliery, pillar working, 184
Low Main seam, Elemore colliery, double-stall working, 229

MACHINES for cutting coal, 113
Main Coal, Eppleton colliery, pillar working, 185, 191
Main Coal, Pontop colliery, pillar working, 179
Main roads underground, 135
Management of men, 53
Manager, the colliery, 48
Marley Hill colliery, method of working pillars at, 178
Marrow, 405
Marshall, Professor Alfred, on the progress of the poorer classes, 30
Marshall, Professor, on purchasing power of wages, 42
Master shifter's report, 69
Master wasteman's report, 70
Maudlin seam, Eppleton colliery, double-stall working, 222
Mechanical coal-cutting, report of N.E. Institute on, 134
Menzies's machine for cutting coal (1761), 113
Mine engineering as a profession, 48
Miners' permanent relief fund, Northumberland and Durham, 47
Miners' savings, 46, 47
Miners' Union founded, 38
Mines (Prohibition of Child Labour Underground) Act, 1900, 395
Mining engineer, education of, 51
Miss-fires, 165
Modified longwall, 198, 201-206, 30,
Monkwearmouth colliery, working Hutton seam beneath Maudlin seam, 238
Montague Main colliery, cost of working, 22
Mothergate, 4, 405
Mount Moor colliery, cost of working, 21
Murton colliery, Co. Durham, method of working pillars at, 184
Murton colliery, near Berwick-on-Tweed, 4

NARROW work, 405
Nicking, 163, 405
Nip-out, 405
Nippers, 405
Nogs, 405
Nook, 405
North of England Mining Institute Report on mechanical coal-cutting, 132
Northumberland steam coal collieries, results at, 264, 266
Nottingham colliery, results at, 282

OFF-HAND labour, 39, 81, 98
Off-takes, 42, 191
Old pillars, removal of, 175

Old Pontop colliery, method of working pillars at, 179
Onsetters, 96
Outbye, 405
Output of coal, 26
Outstroke rent, 405
Over-workings, 59
Overman, 64

PACKWALLS, 405
Palmer, Mr Henry, on right treatment of men, 55
Pamely, Mr Caleb, on colliery manager's qualifications, 53
Panel, 406
Panel system, 159
Panel work, 9
Panel working, actual example of, 170
Park Lane collieries, coal-cutting at, 130
Parting, 406
Pay day, 76
Pay note, 101
Percentage of coal left in pillars, 195
Picks, hewers', 108
Picture, 406
Pike man, 406
Pillaring or pack walls in longwall, 213
Pillars at shallow depths, removal of, 177
Pillars, date of working of, 10, 11, 14
Pillars for supporting shaft, size of, 136
Pillars in early mining, difficulty of working, 6
Pillars made of larger size, 14
Pillars, old, 12
Pillars, removal of, at different depths, 177
Pillars, removal of, by longwall, 206
Pillars, size and shape of, 160
Pillars, working, at depths from 300 to 600 yards, 183
Pillars, working, up to 300 yards depth, 177
"Pitman's Pay," 3[illegible]
Pittington colliery, cost of working, 23
Place, 406
Plan of working in last century, 14
Plans of workings, 61
Plant v. *Cheadle Valley Coal and Iron Company*, 296
Plates, 406
Pollock, Sir F., on legal responsibility, 299
Pontop Pike colliery, wages in 1786, 37
Post, 406
Present condition of labour in collieries, 43
Pressure in relation to depth, 160
Price of coal, 24-26
Prices per yard in bord and pillar working, 172
Profits of collieries, 28, 29
Progress in mine engineering, 30
Proportion of coal wrought by first and second working, 162
Proportion of different classes of underground labour, 98
Public-houses, money taken at, 46
Purchasing power of money, increase in, 42
Putters, 81, 407
Putters' wages formerly, 35
Putting hewers, 77

"RAMBLE," 406
Ramble, payment for, 79
Ramshaw colliery, report on, 12
Rank, putters', 82
Ravensworth colliery, a view of, 4
Reckoning day, 101
Regulator, position of the, 170
Removal of pillars at different depths, 177
Rents, royalty, 59
Repairers, 406
Results in different districts compared, 262, 286
Ribs, removal of, in double-stall working, 224
Ridding, 406
Ridding fallen stone, 87
Riding, 406

Rippers, 406
Ripping, 406
Roadman, 401
Roads, main underground, 150
Robinson, Mr John, the Delaval Papers, 38
Rock binds, 406
Rock-drilling machines, 92
Rogers, Mr, on right treatment of men, 54
Rolleyway, 406
Rolleywayman, 96, 401
Routine of a colliery, daily, 74
Royalty, 406
Royalty rents, their effect, 60
Rules, general, 320
Rules, special, form of, 332
Rules, special, for use of electricity, 348

SAGRE, 406
Sauerbeck, Mr A., on prices of commodities, 42
Savings of miners, 46
Scale of air, 406
Scale of plans, 62
Scallop, to, 406
Score prices for hewing, 77
Screens, wooden, 25
Seaton Burn colliery, method of working pillars at, 177
Seaton Sluice, old wage bill found at, 37
Seggar, 406
Selling price of coal, 23-27
Set-out tubs, 79
Shaft pillars, 136
Shafto v. *Bolckow, Vaughan, & Co., and Ecclesiastical Commissioners*, 10
Shafts in ancient mining, number of, 2
Shafts in early mining, depth of, 5
Sheth, 406
Shift, 406
Shifters, 95
Short workings, 59
Shot-firing, 164
Shovel, hewer's, 109
Side laning, 406
Side of work, 407
Siding-over, 172, 407
Single-stall system in South Wales, 234
Single-stall system of working in Yorkshire, 233
Size of pillars, 160
Skips, 407
Skirting, 172, 191, 407
Slanting a staple, 85
Small putty, 407
Snapping, 407
South Birtley colliery, a view at, 5
South Wales, coal seams of, 255
Special rules for electricity, 348
Special rules, form of, 332
Spedding, Messrs Carlisle and James, 7
Spencer, Mr W., on pillar working, 238
Splint, 407
Sprag, 407
Split, 407
Staffordshire colliery, results at, 280
Staffordshire, thick coal of, 241
Stall working, 222-236
Stanley coal-header, 114, 134A
Staple, 407
Staples, wages for sinking, 93
Steam coal seams in Wales, working of, 255
Stenton, 407
Stephen, Sir J. F., on legal proof of offence, 299
Stint work, 407
Stone, 407
Stone drifting with stub-and-feather, 112
Stone drifts, prices for driving, 90, 192
Stonemen, 83
Stook, 407
Stoppings, 170, 407
Stowing, 407
Stub-and-feather, 111
Stythe, 407
Subsidence, fracture of strata by, 136, 212

"Sump and back end," 166
Surface, damage of, 9, 136, 212
Surveying and planning, 6[illegible]
System of working, common characteristics of, 135
Swally, 407
Swelly, 407

TANFIELD Lea colliery, cost of working, 23
Tanfield Moor colliery, cost of working, 18
Tanfield Moor, number of old shafts, 2
Thick coal of South Staffordshire and Warwickshire, 241
Thick seams, working of, 241
Thill, 407
Thin seam worked by double-stall, 235
Thirling, 407
Thornley colliery, pillar working at, 193
Three-quarter seam, Garesfield colliery, pillar working, 183
Thrust, 5, 161
Timbering in modified longwall working, 204
Timbering of a jud, 185
Tokens, 83, 407
Tons hewed per hewer per shift, 80
Tools, hewers', 109
Topholes, 407
Towneley colliery, method of working pillars at, 179
Trade Union Acts, 1871 and 1876, 300
Trammers, 407
Tree, 407
Trimdon colliery, working Main Coal over Low Main goaf, 238
Trouble, 407
Truck Acts, 300
Tubes for air, 142
Tumble up, 407
Two seams near together, working, 237
Tyne coal-cutter, 132

UNDERCUTTING, inclined, 123
Under looker, 408
Under-manager's daily report, 66
Under the top, 408
Upstanding charges, 105
"Useful performance" of a colliery, 49
Usworth colliery, order of working seams, 238

VARIATION in cost of working coal, 16
Vend, regulation of, 25
Ventilation in panel working, 166
Ventilation of broken workings, 189
Ventilation of drifts, 140
Ventilation, progress of, in coal-mines, 7
Viewer, 408
Viewer, the check, 58

WAGES bills, 99
Wages, former rates of, 34
Wages increased rather than return on capital, 30
Wages not to be paid at public-house, 302
Wages, past compared with present, 39, 41
Wailing, 408
Wallbottle colliery, cost of working, 19
Wales, working coal seams in, 255
Wales . *Thomas*, 298
Walker colliery, 3, 8, 19
Walker, Mr G. B., on coal-cutting, 126
Wall, 4, 408
Wallsend colliery, creep at, 5
Wallsend colliery, explosion at, 7
Wallsend colliery, method of working pillars at, 180
Warrant, 408
Warwickshire colliery, results at, 278
Warwickshire, thick coal of, 241
Wash-out, 408
Waste, 408
Wastemen, 96

Watercourses, old, 31
Welsh bituminous coal colliery, results at, 276
Welsh coal seams, structure of, 255
Welsh steam coal colliery, results at, 274
Welsh steam coal seams, working of, 255
Whim gin, 3
Whole working, 408
Williamson, Mr R. S., on coal-cutting, 132
Willow Bridge colliery, cost of working, 20
Wilson's "Pitman's Pay," 32
Winning, a, 4
Winning headways, 408
Winning places, 15, 137
Witton Park colliery, cost of working, 22
Wood brattice, 142
Wood, Mr Nicholas, on pillar working, 10, 193
Woodifield colliery, working of Five-quarter and Main Coal seams, 238
Working, results of, in different districts, 262, 286
Working coal at the face, manner of, 162-167
Workings, old plan of, 14
Workmen's Compensation Acts, 300, 304

YARD price, 408
  Yard prices in bord and pillar working, 79, 172
Yearly bonds, pitmen's, 33
Yorkshire house and coking colliery, results at, 284

Printed at The Darien Press, *Edinburgh.*

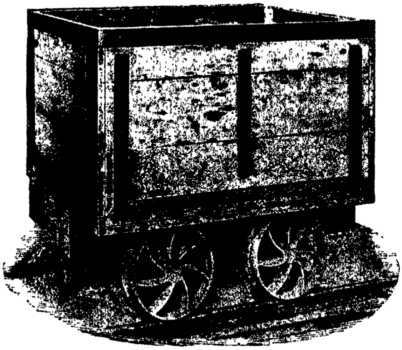
HADFIELD'S

STEEL FOUNDRY CO. LD., SHEFFIELD.

COLLIERY REQUISITES

OF EVERY DESCRIPTION

Including Pit Tubs, fitted up complete in Wood, Iron, or Steel.



MONEY SAVERS.

Patent Prop Withdrawer.
Patent Tub Greaser.
Patent Tub Controller.

SOLE MAKERS OF HADFIELD'S PATENT

"ERA." MANGANESE STEEL,

THE WORLD-RENOWNED MATERIAL FOR

All Castings that have to withstand Abnormal Abrasive Action.

PUBLISHED EVERY FRIDAY.

* * *

Single Copy. 5d.

ANNUAL SUBSCRIPTION, including postage, 24s.

One Guinea per Annum if paid in advance.

Foreign and Colonial Rates, £1 7s. 6d. *Yearly, payable in advance.*

* * *

Special Rates to Colliery Under-Officials and Students.

ESTABLISHED 1858.

Colliery Guardian

AND

JOURNAL OF THE

COAL AND IRON TRADES.

PUBLISHED

BY THE

Colliery Guard

Co. Ltd.,

30 and 31 Furnival

Holborn, London,

* * *

Telegrams—
"Colliery Guardian,
Londo

Telephone—
1354 Holborn.

Price 7s. 6d. net, each Part.

A NEW AND COMPLETE WORK ON

The Mechanical Engineering of Collieries

By T. C. FUTERS.

Part I.—Boring. Sinking. Surface Arrangements. Headgears. Shafts.
Part II.—Winding.
Other Parts to follow.

PROFUSELY ILLUSTRATED.

Price One Shilling net.

ABSTRACT OF THE REPORT OF TH
PRUSSIAN COMMISSION ON

FALLS OF STONE
AND COAL.

This Abstract on Timbering, illustrate by 191 diagrams, has been revised and i reprinted, with Additions, from the *Collier Guardian*, with the official consent of th Prussian Minister of Trade and Commerce

---

In Preparation. **Bound in Cloth, 5s. net.**

ANALYSES OF
BRITISH COAL AND COKE.

During the last two years a series of articles, consisting of Analyses of British Coal and Coke, has been appearing in the *Colliery Guardian*, and four sections have been reprinted in pamphlet form. These reprints are practically exhausted, and the matter is being entirely revised and re-arranged, and will be published, with additions, in one volume. In addition to upwards of 1,000 Analyses of British Coals and Coke, the volume will contain Indexes of Owners and of the Trade Descriptions under which the Coals and Coke are sold whose analyses are given.

The demand for the reprints has been extremely satisfactory, both in this country and abroad, especially amongst Merchants, Shippers, Railway Companies, Gas, Water, and Electrical Power Works, Manufacturers, and large consumers of coal generally.

ROYAL COMMISSION ON
COAL SUPPLIES:

The *Colliery Guardian* Digest of Evidence.

To be completed in Three Vols.

VOL. I.—Working Thin Seams. Limit of Depth in Mining. Waste in Working. Coal-Cutting Machinery. **15/9 net.**

VOL. II.—Economies in the Preparation, Transport, and Use of Coal. **15/ net.**

VOL. III.—The Export of Coal. (*Ready Christmas.*) **15/ net.**

LONDON: THE CHICHESTER PRESS
(Proprietors—THE COLLIERY GUARDIAN COMPANY LIMITED),
30 and 31 Furnival Street, HOLBORN, E.C.

The U.M.S.

Many of the highest mining appointments at home and abroad are held to-day by former students of the U.M.S.

Pupils, Assistants, and Officials of all the leading M.E.'s are present or former students of the U.M.S.

The U.M.S. Course of Study is far more thorough and efficient, and helpful and successful, than attendance at College Lectures and Classes and reading Text Books; also much more convenient and much cheaper in the end. The Mine is the best College. The U.M.S. is the best Tutor. You are not taken away from your practical work at the Colliery.

Many students join the U.M.S. at seventeen and eighteen years of age, and nearly all of them do so on the advice of old students of the U.M.S., and they spread out their work at the Course of Study over a period of two or three years by spending two or three weeks at each Lesson, and they are at liberty to suspend their studies for two or three months each Summer and two or three weeks at other holiday times or during any extra pressure of work; and then, a few years later, when the date of his exam. draws near, the student spends the last few months in carefully revising the Course of Study and in drilling himself with further special practice in exam. work, including previous exam. papers, which are supplied to him for that purpose.

The great advantage of joining the U.M.S. early is that the Lessons direct his attention to many important matters of detail in practical work which would otherwise have escaped his notice entirely, and they help him to take a more intelligent interest in the various work he sees going on at the Mine, and thus to learn much more from his opportunities for picking up practical experience and information during the early years of his training—the period when impressions are strongest and when he has most spare time for study.

A studentship of the U.M.S. is the surest road to a successful career.

You should write at once for the U.M.S. Syllabus, which will be sent post free on application, together with recent testimonials received from students of various ranks and ages in all parts of the world.

T. A. SOUTHERN (late H.M. Inspector of Mines), 303 The U.M.S., Cardiff.

STANLEY

SURVEYING AND DRAWING INSTRUMENTS

of every description, of the highest quality and finish,
at the most moderate prices.

SPECIALITY FOR MINING SURVEY INSTRUMENTS.

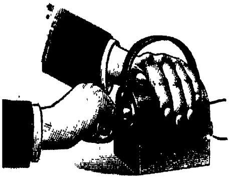
PRICE LIST, POST FREE.

* * *

Sale Rooms **286 HIGH HOLBORN, W.**

Correspondence—

GREAT TURNSTILE, HOLBORN, LONDON, W.C.



SURVEYING INSTRUMENTS

Theodolites, Dials, Levels, Anemometers, Water Gauges.

MINERS' SAFETY LAMPS

• • •

Electric Blasting Apparatus.

• • •

JEFFREY COAL CUTTERS

Air Power and Electric.

• • •

Coal Drills (Air Power and Electric).

Rock Drills (Electric Double Reduction).

NORWALK AIR COMPRESSORS.

JOHN DAVIS & SON (Derby) Ltd.

24 All Saints Works, DERBY.

Published Annually, 1,000 pages, Crown 8vo, Price **8s.** Leather.

The Engineer's Year-Book

OF

FORMULÆ, RULES, TABLES, DATA, AND MEMORANDA

IN

Civil, Mechanical, Electrical, Marine, and Mine Engineering.

By H. R. KEMPE, M.Inst.C.E.

Principal Staff Engineer, Engineer-in-Chief's Office, General Post Office, London,
Author of "A Handbook of Electrical Testing," "The Electrical
Engineer's Pocket Book," etc.

With nearly 1,000 Illustrations specially engraved for the work.

"Kempe's Year-Book really requires no commendation. Its sphere of usefulness is widely known, and is used by engineers the world over."—*The Engineer.*

London: CROSBY LOCKWOOD & SON, 7 Stationers' Hall Court, E.C.

"A Grand Journal."

"An interesting fact in connection with *The Mining Journal* is that with the year 1905 it enters upon the third score and ten years of its existence, having been established in the year 1835. While three score years and ten may be the span of life allotted to man—his period of usefulness drawing at that age to a close—it is not so with *The Mining Journal*. Time has written no wrinkle upon its brow · stronger, brighter, better than ever, and of great good to mining men all over the world."—*Los Angeles Mining Review.*

The Mining Journal,

RAILWAY AND COMMERCIAL GAZETTE.

46 Queen Victoria Street, E.C.

Telephone: Central 4411. Telegrams: "Tutwork, London."

THE OLDEST MINING PAPER AND THE PIONEER OF THE TECHNICAL AND TRADE PRESS OF THE WORLD.

Circulates all over the World, amongst Miners, Metallurgists, Engineers, Manufacturers, Capitalists, and Investors. . . .

Published every Saturday - - price 6d.

SUBSCRIPTIONS—Inland, £1. 4s. per annum. Abroad, £1. 8s. per annum, payable in advance.

The Mining Journal advocates the interests of the Mining and Metallurgical Industries at home and abroad, and has a unique reputation for its Special Correspondence from all the Mining Districts of the World, and also for its Prices Current of Metals, which are bought and sold in all parts of the Globe upon the basis of the "next published *Mining Journal* prices."

The Mining Journal was established more than seventy years ago, and still maintains its position as the leading organ of the World's Press devoted to Mining and its allied interests.

The Mining Journal's advertising pages form a complete Buyers' Directory.

The Mining Journal is neither controlled, nor is any interest in it held or exercised by any Stock Mine-owner, Speculator, or Syndicate, nor is it in any way whatever connected with any Stock or Share Dealing Agency.

The *Monitore Bibliografico Technico-scientifico* of Palermo, in its January issue, contains the following above the signature of the Editor:—"*The Mining Journal* . . . . . To our readers the name of this most important review will not be new, but many perhaps have no better knowledge of it than our summaries afford. I do not say that the perusal of so many abstracts as we publish are sufficient to found a judgment, but they show how great is the intellectual vigour of this paper. The practical importance of the questions treated, the incisive language (the peculiar property of English), the information on the mineral industry of the world, the commercial movement of mineral substances, the technical articles on the more famous mining centres, the notes and articles of unquestionable value on the progress of mineralogical science and its cognates, all deserve recognition in summarising the main features of the most important review with which we have the pleasure of exchanging issues. No other European review, however full, can boast of so many and important correspondents in Australia, America, &c.—in short, to an international chronicle of the industry of the world there is added an intelligent and thoughtful criticism of the art of mining."

Medium 8vo, 1,218 pages, Strongly Bound for Office and Desk use.
Price £1. 5s. net.

The Colliery Manager's Handbook

A Comprehensive Treatise on the Laying-out and Working of Collieries, designed as a Book of Reference for Colliery Managers, and for the use of Coal-Mining Students preparing for First-Class Certificates.

By CALEB PAMELY,

Mining Engineer and Surveyor; Member of the North of England Institute of Mining and Mechanical Engineers, and Member of the South Wales Institute of Mining Engineers.

FIFTH EDITION, CAREFULLY REVISED, AND GREATLY ENLARGED.

Containing over 1,000 Plans, Diagrams, and other Illustrations.

"Mr PAMELY's work is eminently suited to its purpose, being clear, interesting, exhaustive, rich in detail, and giving descriptions of the latest machines in every department. . . . A mining engineer could scarcely go wrong who followed this work."—*Colliery Guardian.*

"This is the most complete 'all-round' work on coal-mining published in the English language. . . . No library of coal-mining books is complete without it."—*Colliery Engineer* (Scranton, Pa., U.S.).

London: CROSBY LOCKWOOD & SON, 7 Stationers' Hall Court, E.C.

Medium 8vo, 328 pages, with about 190 Illustrations, Price 12s. net.

Electricity as Applied to Mining.

BY

ARNOLD LUPTON, M.Inst.C.E. M.I.Mech.E. M.Inst.E.E.
Late Professor of Coal Mining at the Yorkshire College, Victoria University;
Mining Engineer and Colliery Manager.

G. D. ASPINALL PARR, M.Sc. M.Inst.E.E. Assoc.M.I.Mech.E.
Associate of the Central Technical College, City and Guilds of London;
Head of the Electrical Engineering Department, University of Leeds.

And HERBERT PERKIN, M.I.M.E.
Certificated Colliery Manager; Assistant Lecturer in the Mining Department of the
University of Leeds.

Second Edition, thoroughly Revised and Enlarged.

London: CROSBY LOCKWOOD & SON, 7 Stationers' Hall Court,

Small Crown 8vo, 440 pages, with Map of the British Coal Fields, and over 200 Illustrations. Price 4s. 6d. net.

AN ELEMENTARY CLASS BOOK
ON
Practical Coal Mining
FOR THE USE OF
Students attending Classes in preparation for the Board of Education and County Council Examinations, or qualifying for First or Second Class Colliery Managers' Certificates.

By T. H. COCKIN,
Member of the Institution of Mining Engineers; Certificated Colliery Manager; Lecturer on Coal Mining at Sheffield University College.

SECOND EDITION, REVISED.

London: CROSBY LOCKWOOD & SON, 7 Stationers' Hall Court, E.C.

Crown 8vo, 176 pages, Cloth, 3s. 6d. net.

THE
Physics and Chemistry of Mining
AN ELEMENTARY CLASS-BOOK
FOR THE USE OF
Students preparing for the Board of Education and County Council Examinations in Mining, or Qualifying for Colliery Managers' Certificates.

By T. H. BYROM,
Principal Analytical Chemist to the Wigan Coal and Iron Company Limited; Lecturer on Chemistry, and on the Physics and Chemistry of Mining at the Wigan Technical College.

WITH ILLUSTRATIONS.

London: CROSBY LOCKWOOD & SON, 7 Stationers' Hall Court, E.C.

Small Crown 8vo, 200 pages, Price 2s. 6d. Cloth.

NOTES AND FORMULÆ
FOR
MINING STUDENTS
BY
J. H. MERIVALE, M.A.
Late Professor of Mining in the Durham College of Science, Newcastle-upon-Tyne.

Fourth Edition, Revised and Enlarged
BY
H. F. BULMAN, F.G.S.
Assoc. Member of Inst. of Civil Engineers, Member of Federated Institution of Mining Engineers.

London: CROSBY LOCKWOOD & SON, 7 Stationers' Hall Court, E.C.

Small Crown 8vo, 350 pages, Price 3s. 6d. Cloth.

A RUDIMENTARY TREATISE
ON
Coal and Coal Mining
BY THE LATE
Sir WARINGTON W. SMYTH, F.R.S.
Chief Inspector of the Mines of the Crown and of the Duchy of Cornwall.

Eighth Edition, Revised and Extended
BY
T. FORSTER BROWN,
Mining and Civil Engineer; Chief Inspector of the Mines of the Crown and of the Duchy of Cornwall.

London: CROSBY LOCKWOOD & SON, 7 Stationers' Hall Court, E.C.

USEFUL BOOKS FOR

Colliery Officials & Mining Students.

THE COLLIERY MANAGER'S HANDBOOK. By CALEB PAMELY. *See* Advertisement, p. vi.

ELECTRICITY AS APPLIED TO MINING. By LUPTON, PARR, and PERKIN. *See* Advertisement, p. vi.

AN ELEMENTARY CLASS BOOK ON PRACTICAL COAL MINING. By T. H. COCKIN. *See* Advertisement, p. vii.

THE PHYSICS AND CHEMISTRY OF MINING. By T. H. BYROM. *See* Advertisement, p. vii.

NOTES AND FORMULÆ FOR MINING STUDENTS. By MERIVALE and BULMAN. *See* Advertisement, p. viii.

A RUDIMENTARY TREATISE ON COAL AND COAL MINING. By Sir WARINGTON W. SMYTH and T. FORSTER BROWN. *See* Advertisement, p. viii.

MINE DRAINAGE. By STEPHEN MICHELL. Second Edition. Rewritten and Enlarged, with 250 Illustrations. Royal 8vo. Cloth, 25s. net.

STATIONARY ENGINE DRIVING. A Practical Manual for Engineers-in-Charge. By MICHAEL REYNOLDS. Seventh Edition. With Plates and Woodcuts. Crown 8vo. Cloth, 4s. 6d.

LOCOMOTIVE ENGINE DRIVING. A Practical Manual for Engineers-in-Charge. By MICHAEL REYNOLDS. Eleventh Edition. With Illustrations. Crown 8vo. Cloth, 4s. 6d.

THE ENGINEMAN'S POCKET COMPANION. By MICHAEL REYNOLDS. With Illustrations and numerous Diagrams. Fourth Edition. Royal 18mo. 3s. 6d.

RUDIMENTS OF MINERALOGY. By A. RAMSAY, F.G.S. Fourth Edition, Revised and Enlarged. Woodcuts and Plates. Cloth, 3s. 6d.

THE MINERAL SURVEYOR AND VALUER'S COMPLETE GUIDE. By W. LINTERN, M.E. Fourth Edition. With Four Plates. Cloth, 3s. 6d.

SUBTERRANEOUS SURVEYING, With and Without the Magnetic Needle. By THOMAS FENWICK, Surveyor of Mines, and THOMAS BAKER, C.E. Illustrated. Cloth, 2s. 6d.

A TREATISE ON THE METALLURGY OF IRON. By H. BAUERMAN, F.G.S. With numerous Illustrations. Sixth Edition, Revised and Enlarged. Cloth, 5s.

THE IRON ORES OF GREAT BRITAIN AND IRELAND. By J. D. KENDALL, F.G.S., M.E. With Plates and Illustrations. Crown 8vo Cloth, 16s.

THE MINER'S HANDBOOK. A Handy Book of Reference on Mineral Deposits, Mining Operations, &c. By JOHN MILNE, F.R.S. Fcap. 8vo. Leather, 7s. 6d.

POCKET BOOK FOR MINERS AND METALLURGISTS. By F. DANVERS POWER. Fcap. 8vo. Leather, 9s.

A FIRST BOOK OF MINING AND QUARRYING, with the Sciences connected therewith, for Primary Schools and Self-Instruction. By J. H. COLLINS, F.G.S. Cloth, 1s. 6d.

THE MECHANICAL ENGINEER'S POCKET-BOOK OF TABLES, FORMULÆ, RULES, AND DATA. By D. K. CLARK. Fifth Edition. Thoroughly Revised and Enlarged. By H. H. P. POWLES, A.M.Inst.C.E. Fcap. 8vo. Leather, 6s net.

PUMPS AND PUMPING. A Handbook for Pump Users Being Notes on Selection, Construction, and Management. Fourth Edition. By M. POWIS BALE, M.I.M.E. Crown 8vo. Cloth, 2s. 6d.

THE WORKS' MANAGER'S HANDBOOK OF MODERN RULES, TABLES, AND DATA. By W. S. HUTTON, C.E. Sixth Edition. Carefully Revised and Enlarged Medium 8vo. Cloth, 15s.

TEMPLETON'S PRACTICAL MECHANIC'S WORKSHOP COMPANION. Eighteenth Edition. By W. S. HUTTON, C.E. Fcap. 8vo. With numerous Illustrations. Leather, 6s.

A HANDBOOK ON THE STEAM ENGINE, with Special Reference to Small and Medium-sized Engines. By H. HAEDER. Translated by H. H. P. POWLES, A M.I.C.E. Third English Edition. With nearly 1,000 Illustrations. Crown 8vo. Cloth, 7s. 6d. net.

LOCKWOOD'S DICTIONARY OF TERMS USED IN THE PRACTICE OF MECHANICAL ENGINEERING. Comprising upwards of 6,000 Definitions. Edited by JOSEPH G. HORNER, A.M.I.M.E. Third Edition, Revised. Crown 8vo. Cloth, 7s. 6d. net.

TABLES AND MEMORANDA FOR MECHANICS, ENGINEERS, ELECTRICIANS, &c. By FRANCIS SMITH. Seventh Edition. Revised and Enlarged. Waistcoat-pocket size. Leather, 1s. 6d.

THE STANDARD ELECTRICAL DICTIONARY. By T. O'CONOR SLOANE. Second Edition, with Appendix to date. 680 pages. With 390 Illustrations Crown 8vo. Cloth, 7s. 6d net.

THE PROSPECTOR'S HANDBOOK. A Guide for the Prospector and Traveller in search of Metal-bearing and other Valuable Minerals. By J. W. ANDERSON. Small crown 8vo. Cloth, 3s. 6d.; or leather, 4s. 6d.

THE BLOWPIPE IN CHEMISTRY, MINERALOGY, AND GEOLOGY. By W. A. ROSS. Illustrated. Second Edition, Revised and Enlarged. Crown 8vo. Cloth, 5s.

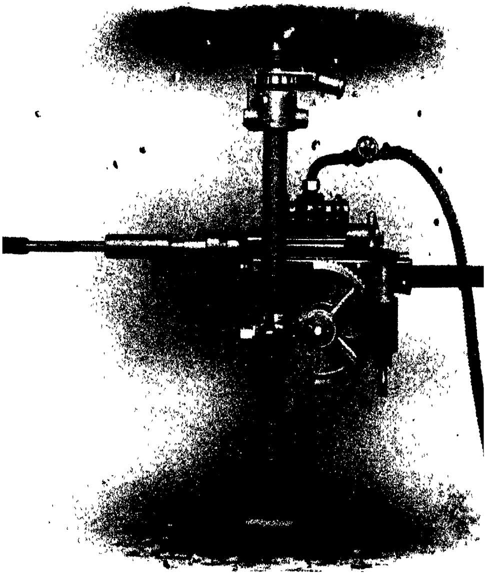
THE ENGINEER'S YEAR-BOOK. Comprising Formulæ, Tables, and Data in Civil, Mechanical, Electrical, Marine, and Mine Engineering. By H. R. KEMPE, M.I.C.E. 924 pages. With 1,000 Illustrations. Crown 8vo. Leather, 8s. *Published Annually.* *See* Advertisement, p. iv.

Full Catalogues of Scientific and Technical Works, post free.

London: CROSBY LOCKWOOD & SON, 7 Stationers' Hall Court, E.C.

iskol’ Coal Cutter.

THE Machine of its class, and the only o
can be instantly adapted to all conditions.



n cut at any height and at any angle from all positions
column. One of the features which accounts for the success
s Machine.

---

ernational Channelling Machines Ltd.,

55 & 56 BISHOPSGATE STREET, WITHIN,
LONDON, E.C.

ms—“CUTTABIT, LONDON.”
ne—1979, LONDON WALL.

CROSBY LOCKWOOD & SON'S

LIST OF WORKS

ON

CIVIL, MECHANICAL, MARINE AND ELECTRICAL ENGINEERING.

A Complete Catalogue of NEW and STANDARD WORKS on MINING and COLLIERY WORKING; ARCHITECTURE and BUILDING; The INDUSTRIAL ARTS, TRADES and MANUFACTURES; CHEMISTRY and CHEMICAL MANUFACTURES; AGRICULTURE, FARMING, GARDENING, AUCTIONEERING, LAND AGENCY, &c. Post Free on Application.

LONDON:
7, STATIONERS' HALL COURT, LUDGATE HILL, E.C.
AND
121a, Victoria Street, Westminster, S.W.
1909

LIST OF WORKS

ON

CIVIL, MECHANICAL, ELECTRICAL AND MARINE ENGINEERING.

ACETYLENE, LIGHTING BY. Generators, Burners, and Electric Furnaces. By WILLIAM E. GIBBS, M.E. With 66 Illustrations. Crown 8vo, cloth ... ... **7s. 6d.**

AERIAL NAVIGATION. A Practical Handbook on the Construction of Dirigible Balloons, Aërostats, Aëroplanes, and Aëromotors. By FREDERICK WALKER, C.E., Associate Member of the Aëronautic Institute. With 104 Illustrations. Large Crown 8vo, cloth ... ... *Net* **7s. 6d.**

AERIAL OR WIRE-ROPE TRAMWAYS. Their Construction and Management. By A. J. WALLIS-TAYLER, A.M.Inst.C.E. With 81 Illustrations. Crown 8vo, cloth ... ... **7s. 6d.**

AIR COMPRESSION. *See* COMPRESSED AIR WORK AND DIVING.

AIR GAS LIGHTING SYSTEMS. *See* PETROL AIR GAS.

ALTERNATING CURRENTS, THE PRINCIPLES OF. For Students of Electrical Engineering. By E. T. LARNER, A.I.E.E., of the Engineering Department, G.P.O., London. 144 pages, with 69 Illustrations. Crown 8vo, cloth. ... [*Just published. Net* **3s. 6d.**

COMPARISON OF CONTINUOUS AND ALTERNATING CURRENTS—SIMPLE HARMONIC MOTION—VECTORIAL REPRESENTATION—ALTERNATING CURRENT THEORY—CIRCUITS IN SERIES—CIRCUITS IN PARALLEL—ALTERNATING CURRENT POWER.

ARMATURE WINDINGS OF DIRECT CURRENT DYNAMOS. Extension and Application of a General Winding Rule. By E. ARNOLD, Engineer, Assistant Professor in Electro-Technics and Machine Design at the Riga Polytechnic School. Translated from the original German by FRANCIS B. DE GRESS, M.E., Chief of Testing Department, Crocker-Wheeler Company. Medium 8vo, 120 pp., with over 140 Illustrations ... ... *Net* **12s.**

BEAMS. EXPERIMENTS ON THEIR FLEXURE. Resulting in the Discovery of New Laws of Failure by Buckling. By ALBERT E. GUY. Medium 8vo, cloth... ... ... *Net* **9s.**

BLAST FURNACE CALCULATIONS AND TABLES FOR FURNACE MANAGERS AND ENGINEERS. Containing Rules and Formulæ for Finding the Dimensions and Output Capacity of any Furnace, as well as the regular Outfit of Stoves, Heating Surface Volume of Air, Tuyère Area, &c., per ton of Iron per day of 24 hours. By JOHN L. STEVENSON. F'cap 8vo, leather *Net* **5s.**

CHAIN CABLES AND CHAINS. Comprising Sizes and Curves of Links, Studs, Etc., Iron for Cables and Chains, Chain Cable and Chain Making, Forming and Welding Links, Strength of Cables and Chains, Certificates for Cables, Marking Cables, Prices of Chain Cables and Chains, Historical Notes, Acts of Parliament, Statutory Tests, Charges for Testing, List of Manufacturers of Cables, Etc., Etc. By THOMAS W. TRAILL, F.E.R.N., M.Inst.C.E., Engineer-Surveyor-in-Chief, Board of Trade, etc. With numerous Tables, Illustrations, and Lithographic Drawings. Folio, cloth .. .. **£2 2s.**

CIVIL ENGINEERING. By HENRY LAW, M.Inst.C.E. Including a Treatise on Hydraulic Engineering by G. R. BURNELL, M.Inst.C.E. Seventh Edition, Revised, with Large Additions on Recent Practice by D. KINNEAR CLARK, M.Inst.C.E. Crown 8vo, cloth ... **6s. 6d.**

COMPRESSED AIR WORK AND DIVING. A Handbook for Engineers, comprising Deep Water Diving and the use of Compressed Air for Sinking Caissons and Cylinders and for Driving Subaqueous Tunnels. By G. W. M. BOYCOTT, Assoc.M.Inst.C.E. With numerous Plates and other Illustrations. Demy 8vo. [*Just ready.* *Net* **10s. 6d.**

STAGE DECOMPRESSION — THE COMMON DIVING DRESS AND HELMET — ROUQUAYROL-DENAYROUZE APPARATUS — FLEUSS DRESS — THE DIVING BELL — PUMPS — PNEUMATIC CAISSONS AND CYLINDERS — TUNNELLING — BLACKWALL AND ROTHERHITHE TUNNELS — EAST RIVER TUNNELS, NEW YORK — ROCK BLASTING — A [illegible] CONDITIONS.

CONDUCTORS FOR ELECTRICAL DISTRIBUTION, their Materials and Manufacture. The Calculation of Circuits, Pole-line Construction, Underground Working, and other Uses. By F. A. C. PERRINE, A.M., D.Sc., Mem.Am.Inst.E.E. Medium 8vo, 300 pp., fully illustrated .. .. *Net* **20s.**

CONTINUOUS RAILWAY BRAKES. A Practical Treatise on the several Systems in Use in the United Kingdom, their Construction and Performance. By M. REYNOLDS. 8vo, cloth ... ... **9s.**

CRANES, the Construction of, and other Machinery for Raising Heavy Bodies for the Erection of Buildings, Etc. By J. GLYNN, F.R.S. Crown 8vo, cloth . . .. **1s. 6d.**

CRANES. — *See also* HOISTING MACHINERY.

CURVES. TABLES OF TANGENTIAL ANGLES AND MULTIPLES. For Setting out Curves from 5 to 200 Radius. By A. BEAZELEY, M.Inst.C.E. Seventh Edition, Revised. With an Appendix on the use of the Tables for Measuring up Curves. Printed on 50 Cards, and sold in a cloth box, waistcoat-pocket size... **3s. 6d.**

DIVING. *See* COMPRESSED AIR, above.

DRAINAGE OF LANDS, TOWNS AND BUILDINGS. By G. D. DEMPSEY, C.E. Revised, with Large Additions on Recent Practice in Drainage Engineering by D. KINNEAR CLARK, M.Inst.C.E. Fourth Edition. Crown 8vo, cloth ... ... **[illegible] 6d.**

DYNAMIC ELECTRICITY AND MAGNETISM, ELEMENTS OF. A Handbook for Students and Electrical Engineers. By PHILIP ATKINSON, A.M., Ph.D. Crown 8vo, cloth, 417 pp., with 120 Illustrations ... ...

DYNAMO BUILDING, HOW TO MAKE A DYNAMO. A Practical Treatise for Amateurs. By A. CROFTS. Crown 8vo, cloth. **2s.**

DYNAMO ELECTRIC MACHINERY. By SAMUEL SHELDON, A.M., Ph.D., Professor of Physics and Electrical Engineering at the Polytechnic Institute of Brooklyn, etc., assisted by HOBART MASON, B.S., E.E. In Two Volumes (Sold separately).

Vol. I.—**DIRECT CURRENT MACHINES.** Sixth Edition, Revised. 292 Illustrations ... ... **12s.** *Net.*

Vol. II.—**ALTERNATING CURRENT MACHINES.** Fifth Edition. With 184 Illustrations ... ... **12s.** *Net.*

DYNAMO MANAGEMENT. A Handybook of Theory and Practice. For the use of Mechanics, Engineers, Students, and others in charge of Dynamos. By G. W. LUMMIS-PATERSON, Electrical Engineer. Fourth Edition, Revised and Enlarged. 300 pp., with 117 Illustrations. Crown 8vo, cloth. ... [*Just published.* *Net* **4s. 6d.**

ELECTRICAL UNITS—MAGNETIC PRINCIPLES—THEORY OF THE DYNAMO—ARMATURES—ARMATURES IN PRACTICE—FIELD MAGNETS—FIELD MAGNETS IN PRACTICE—REGULATION OF DYNAMOS—COUPLING DYNAMOS—INSTALLATION, RUNNING AND MAINTENANCE OF DYNAMOS—FAULTS IN DYNAMOS—FAULTS IN ARMATURES—MOTORS.

"The book may be confidently recommended."—*Engineer.*

DYNAMO, MOTOR, AND SWITCHBOARD CIRCUITS FOR ELECTRICAL ENGINEERS. A Practical Book dealing with the subject of Direct, Alternating, and Polyphase Currents. By WILLIAM R. BOWKER, Consulting Electrical and Street Railway Engineer, Professor of Physics in the University of Southern California, Los Angeles. Second Edition, Revised. Medium 8vo, cloth. With Diagrams .. .. [*Just Published.* *Net* **7s. 6d.**

DYNAMO AND MOTOR CIRCUITS—STARTING AND STOPPING OF SAME—METHODS OF CHANGING DIRECTION OF ROTATION—SYNCHRONISM—PARALLELING OF ALTERNATORS, ETC.—POLYPHASE CIRCUITS—POLYPHASE TRANSMISSION OF POWER—DIPHASE AND TRIPHASE CIRCUITS, ETC.—BOOSTERS—EQUALIZERS—REVERSIBLE BOOSTERS—STORAGE BATTERIES—END-CELL SWITCHES, ETC.—ELECTRIC TRACTION MOTORS—SERIES PARALLEL CONTROLLERS—CAR-WIRING DIAGRAMS—MOTOR VEHICLE CIRCUITS—CANAL HAULAGE—ROTARY CONVERTERS—SWITCHBOARD CIRCUITS, ETC.

DYNAMOS (ALTERNATING AND DIRECT CURRENT). A Text-book on their Construction for Students, Engineer-Constructors and Electricians-in-Charge. By TYSON SEWELL, A.M.I.E.E., Lecturer and Demonstrator in Electrical Engineering at the Polytechnic, Regent Street. 328 pp., with over 230 Illustrations. Large crown 8vo, cloth ... ... *Net* **7s. 6d.**

FUNDAMENTAL PRINCIPLES OF DIRECT CURRENTS—THE MAGNETIC FIELD—THE PRODUCTION OF AN ELECTRO-MOTIVE FORCE—FUNDAMENTAL PRINCIPLES OF ALTERNATING CURRENTS—THE ALTERNATING MAGNETIC FIELD—THE CAPACITY OF THE CIRCUIT—BIPOLAR DYNAMO CONSTRUCTION—THEORY OF BIPOLAR MACHINES—BIPOLAR DYNAMO DESIGN—MULTIPOLAR DYNAMO CONSTRUCTION—MULTIPOLAR DYNAMO DESIGN—SINGLE PHASE ALTERNATORS—CONSTRUCTION OF ALTERNATORS—POLYPHASE ALTERNATORS—EXCITING, COMPOUNDING AND SYNCHRONISING OF ALTERNATORS.

EARTHWORK DIAGRAMS. These Diagrams or Scales have been designed with the intention of reducing the labour connected with the computation of earthwork quantities, and especially those of railways and roads. By R. A. ERSKINE-MURRAY, A.M.Inst.C.E., and Y. D. KIRTON, A.M.Can.Soc.C.E. On a sheet in a roll, *net* **5s.**, or mounted on card, *net* **7s. 6d.**

EARTHWORK MANUAL. By ALEX. J. GRAHAM, C.E. With numerous Diagrams. Second Edition. 18mo, cloth .. **2s. 6d.**

EARTHWORK TABLES. Showing the Contents in Cubic Yards of Embankments, Cuttings, &c., of Heights or Depths up to an average of 80 feet. By JOSEPH BROADBENT, C.E., and FRANCIS CAMPIN, C.E. Crown 8vo, cloth ... ... **5s.**

EARTHWORK TABLES, HANDY GENERAL. Giving the Contents in Cubic Yards of Centre and Slopes of Cuttings and Embankments from 3 inches to 80 feet in Depth or Height, for use with either 66 feet Chain or 100 feet Chain. By J. H. WATSON BUCK, M.Inst.C.E. On a Sheet mounted in cloth case ... ... **3s. 6d.**

ELECTRIC LIGHT. Its Production and Use. By J. W. URQUHART. Crown 8vo, cloth .. .. **7s. 6d.**

ELECTRIC LIGHT FITTING. A Handbook for Working Electrical Engineers. By J. W. URQUHART. Crown 8vo, cloth **5s.**

ELECTRIC LIGHT FOR COUNTRY HOUSES. A Practical Handbook, including Particulars of the Cost of Plant and Working. By J. H. KNIGHT. Crown 8vo, wrapper .. .. **1s.**

ELECTRIC LIGHTING. By ALAN A. CAMPBELL SWINTON, M.Inst.C.E., M.I.E.E. Crown 8vo, cloth .. ... **1s. 6d.**

ELECTRIC LIGHTING AND HEATING. A POCKET BOOK. Comprising useful Formulæ, Tables, Data, and Particulars of Apparatus and Appliances for the Use of Central Station Engineers, Contractors, and Engineers-in-Charge. By SYDNEY F. WALKER, R.N., M.I.E.E., M.I.M.E., A.M.Inst.C.E., Etc. F'cap 8vo, 448 pp., 27 Diagrams, and 240 Tables .. .. *Net* **7s. 6d**

DEFINITION—DIFFERENT USES EMPLOYED—LAWS OF ELECTRIC CIRCUITS—DIFFERENC BETWEEN WORKING OF CONTINUOUS AND ALTERNATING CURRENTS—LAWS OF ELECTR MAGNETIC AND ELECTRO-STATIC INDUCTION—ELECTRICITY GENERATORS—ACCUMULATORS—SWITCHBOARDS, SWITCHES, CIRCUIT BREAKERS, ETC.—CABLES—METHODS OF INSULATION—SIZES AND INSULATION OF CABLES MADE BY LEADING MAKERS—CONDUITS—LEADING WIRE AND OTHER ACCESSORIES—MEASURING INSTRUMENTS OF ALL KINDS AND APPARATUS FO TESTING LAMPS AND ACCESSORIES—APPARATUS FOR HEATING BY ELECTRICITY.

ELECTRIC SHIP-LIGHTING. A Handbook on the Practica Fitting and Running of Ship's Electrical Plant. By J. W. URQUHAR Crown 8vo, cloth **7s. 6d**

ELECTRIC WIRING, DIAGRAMS AND SWITCH BOARDS. By NEWTON HARRISON, E.E., Instructor of Electrica Engineering in the Newark Technical School. Crown 8vo, cloth *Net* **5**

THE BEGINNING OF WIRING—CALCULATING THE SIZE OF WIRE—A SIMPLE ELECTRIC LIG CIRCUIT CALCULATED—ESTIMATING THE MAINS, FEEDERS, AND BRANCHES—USING THE BRID FOR TESTING THE INSULATION RESISTANCE—WIRING FOR MOTORS—WIRING WITH CLEAT MOULDING AND CONDUIT—LAYING OUT A CONDUIT SYSTEM—POWER REQUIRED FOR LAMPS LIGHTING OF A ROOM—SWITCHBOARDS AND THEIR PURPOSE—SWITCHBOARDS DESIGNED F SHUNT AND COMPOUND-WOUND DYNAMOS—PANEL SWITCHBOARDS, STREET RAILWAY SWITC BOARDS, LIGHTNING ARRESTERS—THE GROUND DETECTOR—LOCATING GROUNDS—ALTERNATI CURRENT CIRCUITS—THE POWER FACTOR IN CIRCUITS—CALCULATION OF SIZES OF WIRE F SINGLE, TWO AND THREE PHASE CIRCUITS.

ELECTRICAL AND MAGNETIC CALCULATIONS For the use of Electrical Engineers and Artisans, Teachers, Student and all others interested in the Theory and Application of Electricity an Magnetism. By A. A. ATKINSON, M.S., Professor of Physics an Electricity in Ohio University, Athens, Ohio. Crown 8vo, cloth *Net* 9s

ELECTRICAL DICTIONARY. A Popular Encyclopædia c Words and Terms used in the Practice of Electrical Engineerin By T. O'CONOR SLOANE, A.M., E.M., Ph.D. Fourth Edition, wit Appendix. 690 pages and nearly 400 Illustrations. Large Crown 8v cloth ... ... *Net* **7s. 6d**

"The work has many attractive features in it, and is beyond doubt, a well put together an useful publication. The amount of ground covered may be gathered from the fact that in the inde about 3,000 references will be found."—*Electrical Review.*

ELECTRICAL ENGINEERING. A First Year's Course for Students. By TYSON SEWELL, A.M.I.E.E., Lecturer and Demonstrator in Electrical Engineering at the Polytechnic, Regent Street, London. Fourth Edition, Revised, with Additions. Large Crown 8vo, cloth. 462 pp., with 278 Illustrations ... ... *Net* **5s.**

OHM'S LAW—UNITS EMPLOYED IN ELECTRICAL ENGINEERING—SERIES AND PARALLEL CIRCUITS—CURRENT DENSITY AND POTENTIAL DROP IN THE CIRCUIT—THE HEATING EFFECT OF THE ELECTRIC CURRENT—THE MAGNETIC EFFECT OF AN ELECTRIC CURRENT—THE MAGNETISATION OF IRON—ELECTRO-CHEMISTRY—PRIMARY BATTERIES—ACCUMULATORS—INDICATING INSTRUMENTS—AMMETERS, VOLTMETERS, OHMMETERS—ELECTRICITY SUPPLY METERS—MEASURING INSTRUMENTS, AND THE MEASUREMENT OF ELECTRICAL RESISTANCE—MEASUREMENT OF POTENTIAL DIFFERENCE, CAPACITY, CURRENT STRENGTH, AND PERMEABILITY—ARC LAMPS—INCANDESCENT LAMPS, MANUFACTURE AND INSTALLATION—PHOTOMETRY—THE CONTINUOUS CURRENT DYNAMO—DIRECT CURRENT MOTORS—ALTERNATING CURRENTS—TRANSFORMERS, ALTERNATORS, SYNCHRONOUS MOTORS—POLYPHASE WORKING—APPENDIX I., THE THREE WIRE SYSTEM—APPENDIX II., QUESTIONS AND ANSWERS.

"Distinctly one of the best books for those commencing the study of electrical engineering. Everything is explained in simple language which even a beginner cannot fail to understand."—*The Engineer.*

ELECTRICAL ENGINEERING (ELEMENTARY). In Theory and Practice. A Class Book for Junior and Senior Students and Working Electricians. By J. H. ALEXANDER. With nearly 200 illustrations. Crown 8vo, cloth ... ... *Net* **3s. 6d.**

FUNDAMENTAL PRINCIPLES—ELECTRICAL CURRENTS—SOLENOID COILS, GALVANOMETERS—VOLT METERS—MEASURING INSTRUMENTS—ALTERNATING CURRENTS—DYNAMO ELECTRIC MACHINES—CONTINUOUS CURRENT DYNAMOS—INDUCTION, STATIC TRANSFORMERS, CONVERTERS—MOTORS—PRIMARY AND STORAGE CELLS—ARC LAMPS—INCANDESCENT LAMPS—SWITCHES, FUSES, ETC.—CONDUCTORS AND CABLES—ELECTRICAL ENERGY METERS—SPECIFICATIONS—GENERATION AND TRANSMISSION OF ELECTRICAL ENERGY—GENERATING STATIONS.

ELECTRICAL ENGINEERING. *See* ALTERNATING CURRENTS.

ELECTRICAL TRANSMISSION OF ENERGY. A Manual for the Design of Electrical Circuits. By ARTHUR VAUGHAN ABBOTT, C.E., Member American Institute of Electrical Engineers, etc. Fourth Edition, Rewritten and Enlarged, with numerous Tables, Plates, and other Illustrations. Royal 8vo, 700 pages. Strongly bound in cloth ... ... *Net* **30s.**

INTRODUCTION—THE PROPERTIES OF WIRE—THE CONSTRUCTION OF AERIAL CIRCUITS—GENERAL LINE WORK—ELECTRIC RAILWAY CIRCUITS—PROTECTION—THE CONSTRUCTION OF UNDERGROUND CIRCUITS—CONDUITS—CABLES AND CONDUIT CONDUCTORS—SPECIAL RAILWAY CIRCUIT—THE INTERURBAN TRANSMISSION LINE—THE THIRD RAIL—THE URBAN CONDUIT—ELECTRICAL INSTRUMENTS—METHODS OF ELECTRICAL MEASUREMENT—CONTINUOUS-CURRENT CONDUCTORS—THE HEATING OF CONDUCTORS—CONDUCTORS FOR ALTERNATING CURRENTS—SERIES DISTRIBUTION—PARALLEL DISTRIBUTION—MISCELLANEOUS METHODS—POLYPHASE TRANSMISSION—THE COST OF PRODUCTION AND DISTRIBUTION.

ELECTRICITY AS APPLIED TO MINING. By **Arnold Lupton**, M.Inst.C.E., M.I.Mech.E., M.I.E.E., late Professor of Coal Mining at the Yorkshire College, Victoria University; G. D. **Aspinall Parr**, M.I.E.E., A.M.I.Mech.E., Head of the Electrical Engineering Department, Yorkshire College, Victoria University; and **Herbert Perkin**, M.I.M.E., Assistant Lecturer in the Mining Department of the Yorkshire College, Victoria University. Second Edition, Revised and Enlarged, medium 8vo, cloth, 300 pp., with about 170 illustrations. *Net* **12s.**

Introductory—Dynamic Electricity—Driving of the Dynamo—The Steam Turbine—Distribution of Electrical Energy—Starting and Stopping Electrical Generators and Motors—Electric Cables—Central Electrical Plants—Electricity Applied to Pumping and Hauling—Electricity Applied to Coal Cutting—Typical Electric Plants recently Erected—Electric Lighting by Arc and Glow Lamps—Miscellaneous Applications of Electricity—Electricity as Compared with other Modes of Transmitting Power—Dangers of Electricity.

"The book is a first attempt to meet a growing want, and is well worthy of a place in the mining engineer's library."—*Colliery Guardian.*

ELECTRICITY IN FACTORIES AND WORKSHOPS: ITS COST AND CONVENIENCE. A Handybook for Power Producers and Power Users. By A. P. Haslam, M.I.E.E. 328 pp., with numerous Illustrations. Large crown 8vo, cloth.

[*Just published.* *Net* **7s. 6d.**

The Electric Motor and its Advantages—The Direct Current Motor—The Alternating Current Motor—The Starting and Speed Regulation of Electric Motors—The Efficiency and [illegible] of Electric Motors—The Provision of Electric Energy—The Cost of Energy as Affected by Conditions of Working—The Question of the Supply Power Company—[illegible] Generating Plant—Oil and Gas Engine Plant—Producer Gas Plant—Steam Plant—Power Station Tariffs—The Advantages of Electric Driving—The [illegible] of Power in Textile Factories—Electric Power in [illegible] Works—The Use of Electric Power in Engineering Works [illegible] Power—The Installation of Electric Motors—[illegible] Improvements.

ELECTRICITY. A STUDENT'S TEXT-BOOK. By H. M. Noad, F.R.S. 650 pp., 470 illustrations. Crown 8vo ... ... **9s.**

ELECTRICITY, POWER TRANSMITTED BY, AND APPLIED BY THE ELECTRIC MOTOR, including Electric Railway Construction. By Philip Atkinson, A.M., Ph.D., author of "Elements of Static Electricity." Fourth Edition, Enlarged. Crown 8vo, cloth, 224 pp., with over 80 illustrations . .. . *Net* **9s.**

ELECTRO-PLATING AND ELECTRO-REFINING OF METALS. Being a new edition of Alexander Watt's "Electro-Deposition." Revised and Largely Re-written by **Arnold Philip**, Assoc. R.S.M., B.Sc., A.I.E.E., F.I.C., Principal Assistant to the Admiralty Chemist, formerly Chief Chemist to the Engineering Departments of the India Office. 700 pp., with numerous Illustrations, Large Crown 8vo, cloth . ... *Net* **12s. 6d.**

ENGINE DRIVING LIFE. Stirring Adventures and Incidents in the Lives of Locomotive Engine-Drivers. By **Michael Reynolds.** Third Edition. Crown 8vo, cloth ... . **1s. 6d.**

ENGINEERING DRAWING. A WORKMAN'S MANUAL. By **John Maxton**, Instructor in Engineering Drawing, Royal Naval College, Greenwich. Eighth Edition. 300 Plates and Diagrams. Crown 8vo, cloth ... ... **3s. 6d.**

"A copy of it should be kept for reference in every drawing office."—*Engineering.*

ENGINEERING ESTIMATES, COSTS, & ACCOUNTS. A Guide to Commercial Engineering. With numerous examples of Estimates and Costs of Millwright Work, Miscellaneous Productions, Steam Engines and Steam Boilers; and a Section on the Preparation of Costs Accounts. By A GENERAL MANAGER. Second Edition. 8vo, cloth ... ... **12s.**

"The information is given in a plain, straightforward manner, and bears throughout evidence of the intimate practical acquaintance of the author with every phase of commercial engineering."—*Mechanical World.*

ENGINEERING PROGRESS (1863-6). By WM. HUMBER, A.M.Inst.C.E. Complete in Four Vols. Containing 148 Double Plates, with Portraits and Copious Descriptive Letterpress. Imperial 4to, half morocco. Price, complete, **£12 12s.**; or each volume sold separately at **£3 3s.** per Volume. Descriptive List of Contents on application.

ENGINEER'S AND MILLWRIGHT'S ASSISTANT. A Collection of Useful Tables, Rules, and Data. By WILLIAM TEMPLETON. Eighth Edition, with Additions. 18mo cloth ... ... **2s. 6d.**

"A deservedly popular work. It should be in the drawer of every mechanic."—*English Mechanic.*

ENGINEER'S HANDBOOK. A Practical Treatise on Modern Engines and Boilers, Marine, Locomotive, and Stationary. And containing a large collection of Rules and Practical Data relating to Recent Practice in Designing and Constructing all kinds of Engines, Boilers, and other Engineering work. The whole constituting a comprehensive Key to the Board of Trade and other Examinations for Certificates of Competency in Modern Mechanical Engineering. By WALTER S. HUTTON, Civil and Mechanical Engineer, Author of "The Works' Manager's Handbook for Engineers," etc. With upwards of 420 Illustrations. Sixth Edition, Revised and Enlarged. Medium 8vo, nearly 560 pp., strongly bound ... ... **18s.**

"A mass of information set down in simple language, and in such a form that it can be easily referred to at any time. The matter is uniformly good and well chosen, and is greatly elucidated by the illustrations. The book will find its way on to most engineers' shelves, where it will rank as one of the most useful books of reference."—*Practical Engineer.*

"Full of useful information, and should be found on the office shelf of all practical engineers."—*English Mechanic.*

ENGINEER'S, MECHANIC'S, ARCHITECT'S, BUILDER'S, ETC., TABLES AND MEMORANDA. Selected and Arranged by FRANCIS SMITH. Seventh Edition, Revised, including ELECTRICAL TABLES, FORMULÆ, and MEMORANDA. Waistcoat pocket size, limp leather ... ... **1s. 6d.**

"The best example we have ever seen of 270 pages of useful matter packed into the dimensions of a card-case."—*Building News.*

ENGINEER'S YEAR-BOOK FOR 1909. Comprising Formulæ, Rules, Tables, Data and Memoranda in Civil, Mechanical, Electrical, Marine and Mine Engineering. By H. R. KEMPE, M.Inst.C.E., Electrician to the Post Office formerly, Principal Staff Engineer, Engineer-in-Chief's Office, General Post Office, London, Author of "A Handbook of Electrical Testing," "The Electrical Engineer's Pocket-Book," etc. With 1,000 Illustrations, specially Engraved for the work. Crown 8vo, 950 pp., leather ... ... [*Just Published.* **8s.**

"Kempe's Year-Book really requires no commendation. Its sphere of usefulness is widely known, and it is used by engineers the world over."—*The Engineer.*

"The volume is distinctly in advance of most similar publications in this country."—*Engineering.*

ENGINEMAN'S POCKET COMPANION, and Practica Educator for Enginemen, Boiler Attendants, and Mechanics. B MICHAEL REYNOLDS. With 45 Illustrations and numerous Diagrams Fifth Edition. Royal 18mo, strongly bound for pocket wear 3s. 6d

EXCAVATION (EARTH AND ROCK). A Practica Treatise, by CHARLES PRELINI, C.E. 365 pp., with Tables, man Diagrams and Engravings Royal 8vo, cloth ... ... *Net* 16s

FACTORY ACCOUNTS. Their Principles and Practice. A Handbook for Accountants and Manufacturers. By GARCKE E. an J. M. FELLS. Crown 8vo, cloth 7s. 6d

FIRES, FIRE-ENGINES, AND FIRE BRIGADES. With a History of Fire-Engines, their Construction, Use, and Management. Hints on Fire Brigades, &c By C. F. T. YOUNG, C.E. 8vo, cloth £1 4s.

FOUNDATIONS AND CONCRETE WORKS. With Practical Remarks on Footings, Planking, Sand and Concrete, Béton, Pile driving, Caissons, and Cofferdams. By E DOBSON Crown 8vo. 1s. 6d.

FUEL, ITS COMBUSTION AND ECONOMY. Consisting of an Abridgement of "A Treatise on the Combustion of Coal and the Prevention of Smoke." By C. W. WILLIAMS, A.Inst C.E. With extensive Additions by D. KINNEAR CLARK, M.Inst.C.E. Fourth Edition Crown 8vo, cloth ... ... 3s. 6d.

FUELS: SOLID, LIQUID, AND GASEOUS. Their Analysis and Valuation For the Use of Chemists and Engineers. By H. J. PHILLIPS, F.C.S., formerly Analytical and Consulting Chemist to the Great Eastern Railway. Fourth Edition. Crown 8vo, cloth 2s. 0d.

GAS AND OIL ENGINE MANAGEMENT. A Practical Guide for Users and Attendants, being Notes on Selection, Construction and Management. By M POWIS BALL, M.Inst.C.E., M.I.Mech.E., Author of "Woodworking Machinery," etc. Second Edition, with an additional Chapter on Gas Producers. Crown 8vo, cloth *Net* 3s. 6d.

SELECTING AND FIXING A GAS ENGINE—PRINCIPLE OF WORKING, ETC.—FAILURES AND DEFECTS IN VALVES, IGNITION, PISTON RINGS, ETC.—OIL ENGINES—GAS PRODUCERS—RULES, TABLES, ETC.

GAS ENGINEER'S POCKET-BOOK. Comprising Tables, Notes and Memoranda relating to the Manufacture, Distribution, and Use of Coal Gas and the Construction of Gas Works. By H. O'CONNOR, A.M.Inst.C.E. Third Edition, Revised. Crown 8vo, leather *Net* 10s. 6d.

"The book contains a vast amount of information."—*Gas World.*

GAS-ENGINE HANDBOOK. A Manual of Useful Information for the Designer and the Engineer. By E. W. ROBERTS, M.E. With Forty Full-page Engravings. Small F'cap. 8vo, leather *Net* 8s. 6d.

GAS-ENGINES AND PRODUCER-GAS PLANTS. A Treatise setting forth the Principles of Gas Engines and Producer Design, the Selection and Installation of an Engine, the Care of Gas Engines and Producer-Gas Plants, with a Chapter on Volatile Hydrocarbon and Oil Engines. By R. E. Mathot, M.E. Translated from the French. With a Preface by Dugald Clerk, M.Inst.C.E., F.C.S. Medium 8vo, cloth, 310 pages, with about 150 Illustrations *Net* 12s.

Motive Power and Cost of Installation—Selection of an Engine—Installation of an Engine—Foundations and Exhaust—Water Circulation—Lubrication—Conditions of Perfect Operation—How to Start an Engine—Precautions—Perturbations in the Operation of Engines—Producer-Gas Engines—Producer-Gas—Pressure Gas Producers—Suction Gas-Producers—Oil and Volatile Hydrocarbon Engines—The Selection of an Engine.

GAS ENGINES. With Appendix describing a Recent Engine with Tube Igniter. By T. M. Goodeve, M.A. Crown 8vo, cloth **2s. 6d.**

GAS ENGINES. *See also* Internal Combustion Engines

GAS LIGHTING. *See also* Acetylene.

GAS LIGHTING, FOR COUNTRY HOUSES. *See* Petrol Air Gas.

GAS MANUFACTURE, CHEMISTRY OF. A Practical Manual for the Use of Gas Engineers, Gas Managers and Students. By Harold M. Royle, F.C.S., Chief Chemical Assistant at the Beckton Gas Works. Demy 8vo, cloth. 340 pages, with numerous Illustrations and Coloured Plate ... . *Net* **12s. 6d.**

Preparation of Standard Solutions—Analysis of Coals—Description of Various Types of Furnaces—Products of Carbonisation at Various Temperatures—Analysis of Crude Gas—Analysis of Lime—Analysis of Ammoniacal Liquor—Analytical Valuation of Oxide of Iron—Estimation of Naphthalin—Analysis of Fire Bricks and Fire Clay—Art of Photometry—Carburetted Water Gas—Appendix containing Statutory and Official Regulations for Testing Gas, Valuable Excerpts from Various Important Papers on Gas Chemistry, Useful Tables, Memoranda, etc.

GAS WORKS. Their Construction and Arrangement, and the Manufacture and Distribution of Coal Gas. By S. Hughes, C.E. Ninth Edition. Revised with Notices of Recent Improvements, by Henry O'Connor, A.M.Inst.C.E. Crown 8vo, cloth ... . .. **6s.**

GEOMETRY. For the Architect, Engineer, and Mechanic. By E. W. Tarn, M.A., Architect. 8vo, cloth .. .. . . **9s.**

GEOMETRY FOR TECHNICAL STUDENTS. By E. H. Sprague, A.M.Inst.C.E. Crown 8vo, cloth ... ... *Net* **1s.**

GEOMETRY OF COMPASSES. By Oliver Byrne. Coloured Plates. Crown 8vo, cloth . . .. **3s. 6d.**

HEAT, EXPANSION OF STRUCTURES BY. By John Keily, C.E. Crown 8vo, cloth . ... **3s. 6d.**

HOISTING MACHINERY. Including the Elements of Crane Construction and Descriptions of the Various Types of Cranes in Use. By Joseph Horner, A.M.I.M.E. Crown 8vo, cloth, with 215 Illustrations, including Folding Plates ... . *Net* **7s. 6d.**

HYDRAULIC MANUAL. Consisting of Working Tables and Explanatory Text Intended as a Guide in Hydraulic Calculations and Field Operations. By Lowis D'A. Jackson. Fourth Edition, Enlarged. Large Crown 8vo, cloth ... ... - ... ... **16s.**

HYDRAULIC POWER ENGINEERING. A Practical Manual on the Concentration and Transmission of Power by Hydraulic Machinery. By G. CROYDON MARKS, A.M.Inst.C.E. Second Edition, Enlarged, with about 240 Illustrations. 8vo, cloth ... *Net* **10s. 6d.**

SUMMARY OF CONTENTS.—PRINCIPLES OF HYDRAULICS—THE FLOW OF WATER—HYDRAULIC PRESSURES—MATERIAL—TEST LOAD—PACKING FOR SLIDING SURFACES—PIPE JOINTS—CONTROLLING VALVES—PLATFORM LIFTS—WORKSHOP AND FOUNDRY CRANES—WAREHOUSE AND DOCK CRANES—HYDRAULIC ACCUMULATORS—PRESSES FOR BALING AND OTHER PURPOSES—SHEET METAL WORKING AND FORGING MACHINERY—HYDRAULIC RIVETERS—HAND AND POWER PUMPS—STEAM PUMPS—TURBINES—IMPULSE TURBINES—REACTION TURBINES—DESIGN OF TURBINES IN DETAIL—WATER WHEELS—HYDRAULIC ENGINES—RECENT ACHIEVEMENTS—PRESSURE OF WATER—ACTION OF PUMPS, ETC.

HYDRAULIC TABLES, CO-EFFICIENTS, AND FORMULÆ. For Finding the Discharge of Water from Orifices, Notches, Weirs, Pipes, and Rivers. With New Formulæ, Tables, and General Information on Rain-fall, Catchment-Basins, Drainage, Sewerage, Water Supply for Towns and Mill Power. By JOHN NEVILLE, C.E., M.R.I.A. Third Edition, Revised, with additions. Numerous Illustrations. Crown 8vo, cloth ... ... **14s.**

INTERNAL COMBUSTION ENGINES. Their Theory, Construction, and Operation. By ROLLA C. CARPENTER, M.M.E., LL.D., and H. DIEDERICHS, M.E., Professors of Experimental Engineering, Sibley College, Cornell University. 610 pages, with 373 Illustrations. Medium 8vo, cloth ... [*Just published. Net* **21s.**

INTRODUCTION, DEFINITIONS AND CLASSIFICATION, INDICATED AND BRAKE HORSE-POWER—THERMODYNAMICS OF THE GAS ENGINE—THEORETICAL COMPARISON OF VARIOUS TYPES OF INTERNAL COMBUSTION ENGINES—THE VARIOUS EVENTS OF THE CONSTANT-VOLUME AND CONSTANT PRESSURE CYCLE AS MODIFIED BY PRACTICAL CONDITIONS—THE TEMPERATURE ENTROPY DIAGRAM APPLIED TO THE GAS ENGINE—COMBUSTION—GAS-ENGINE FUELS, THE SOLID FUELS, GAS PRODUCERS—THE GAS ENGINE FUELS, LIQUID FUELS, CARBURETTERS AND VAPORISERS—GAS ENGINE FUELS, THE GAS FUELS, THE FUEL MIXTURE EXPLOSIBILITY, PRESSURE AND TEMPERATURE—THE HISTORY OF THE GAS ENGINE—MODERN TYPES OF INTERNAL COMBUSTION ENGINE—GAS ENGINE AUXILIARIES, IGNITION, MUFFLERS, AND STARTING APPARATUS—REGULATION OF INTERNAL COMBUSTION ENGINES—THE ESTIMATION OF POWER OF GAS ENGINES—METHODS OF TESTING INTERNAL COMBUSTION ENGINES—THE PERFORMANCE OF GAS ENGINES AND GAS PRODUCERS—COST OF INSTALLATION AND OF OPERATION.

IRON AND METAL TRADES COMPANION. For Expeditiously Ascertaining the Value of any Goods bought or sold by Weight, from 1s. per cwt. to 112s. per cwt., and from one farthing per pound to one shilling per pound. By THOMAS DOWNIE. Strongly bound in leather, 396 pp. ... ... **9s.**

IRON AND STEEL. A Work for the Forge, Foundry, Factory, and Office. Containing ready, useful, and trustworthy Information for Ironmasters and their Stock-takers; Managers of Bar, Rail, Plate, and Sheet Rolling Mills; Iron and Metal Founders; Iron Ship and Bridge Builders; Mechanical, Mining, and Consulting Engineers; Architects, Contractors, Builders, etc. By CHARLES HOARE, Author of "The Slide Rule," etc. Ninth Edition. 32mo, leather ... ... **6s.**

IRON AND STEEL CONSTRUCTIONAL WORK, as applied to Public, Private, and Domestic Buildings. By FRANCIS CAMPIN, C.E. Crown 8vo, cloth ... ... **3s. 6d.**

IRON AND STEEL GIRDERS. A Graphic Table for Facilitating the Computation of the Weights of Wrought Iron and Steel Girders, etc., for Parliamentary and other Estimates. By J. H. WATSON BUCK, M.Inst.C.E. On a Sheet ... ... **2s. 6d.**

IRON-PLATE WEIGHT TABLES. For Iron Shipbuilders, Engineers, and Iron Merchants. Containing the Calculated Weights of upwards of 150,000 different sizes of Iron Plates from 1 ft. by 6 in. by ¼ in. to 10 ft. by 5 ft. by 1 in. Worked out on the basis of 40 lbs. to the square foot of Iron 1 in. in thickness. By H. BURLINSON and W. H. SIMPSON. 4to, half-bound ... ... **£1 5s.**

IRRIGATION (PIONEER). A Manual of Information for Farmers in the Colonies. By E. O. MAWSON, M.Inst.C.E., Executive Engineer, Public Works Department, Bombay. With Chapters on Light Railways by E. R. CALTHROP, M.Inst.C.E., M.I.M.E. With Plates and Diagrams. Demy 8vo, cloth .. .. *Net* **10s. 6d.**

VALUE OF IRRIGATION, AND SOURCES OF WATER SUPPLY—DAMS AND WEIRS—CANALS—UNDERGROUND WATER—METHODS OF IRRIGATION—SEWAGE IRRIGATION—IMPERIAL AUTOMATIC SLUICE GATES—THE CULTIVATION OF IRRIGATED CROPS, VEGETABLES, AND FRUIT TREES—LIGHT RAILWAYS FOR HEAVY TRAFFIC—USEFUL MEMORANDA AND DATA.

LATHE PRACTICE. A Complete and Practical Work on the Modern American Lathe. By OSCAR E. PERRIGO, M.E., Author of "Modern Machine Shop Construction, Equipment, and Management," etc. Medium 8vo, 424 pp., 315 illustrations. Cloth ... *Net* **12s.**

HISTORY OF THE LATHE UP TO THE INTRODUCTION OF SCREW THREADS—ITS DEVELOPMENT SINCE THE INTRODUCTION OF SCREW THREADS—CLASSIFICATION OF LATHES—LATHE DESIGN: THE BED AND ITS SUPPORTS—THE HEAD STOCK CASTING, THE SPINDLE, AND SPINDLE-CONE—THE SPINDLE BEARINGS, THE BACK GEARS AND THE TRIPLE GEAR MECHANISM—THE TAIL STOCK, THE CARRIAGE, THE APRON, ETC.—TURNING RESTS, SUPPORTING RESTS, SHAFT STRAIGHTENERS, ETC.—LATHE ATTACHMENTS—RATIO CHANGE GEAR MECHANISMS—LATHE TOOLS, HIGH-SPEED STEEL, SPEEDS AND FEEDS, POWER FOR CUTTING TOOLS, ETC.—TESTING A LATHE—LATHE WORK—ENGINE LATHES—HEAVY LATHES—HIGH-SPEED LATHES—SPECIAL LATHES—REGULAR TURRET LATHES—SPECIAL TURRET LATHES—ELECTRICALLY-DRIVEN LATHES.

LATHE-WORK. A Practical Treatise on the Tools, Appliances, and Processes employed in the Art of Turning. By PAUL N. HASLUCK. Eighth Edition. Crown 8vo, cloth .. .. **5s.**

LAW FOR ENGINEERS AND MANUFACTURERS. See EVERY MAN'S OWN LAWYER. A Handybook of the Principles of Law and Equity. By a Barrister. Forty-sixth (1909) Edition. Revised and Enlarged, including Abstracts of the Legislation of 1906-8 of especial interest to Engineering Firms and Manufacturers, such as the Workmen's Compensation Act, 1906; the Prevention of Corruption Act, 1906; the Trades Disputes Act, 1906; the Census of Production Act, 1906; the New Companies Act, 1907; the Limited Partnerships Act, 1907; the Patent and Designs Act, 1907, and many other recent Acts. Large crown 8vo, cloth, 838 pages .. ... [*Just published.* *Net* **6s. 8d.**

LEVELLING, PRINCIPLES AND PRACTICE OF. Showing its Application to Purposes of Railway and Civil Engineering in the Construction of Roads; with Mr. TELFORD'S Rules for the same. By FREDERICK W. SIMMS, M.Inst.C.E. Ninth Edition, with LAW'S Practical Examples for Setting-out Railway Curves, and TRAUTWINE'S Field Practice of Laying-out Circular Curves. With seven Plates and numerous Woodcuts. 8vo ... ... **8s. 6d.**

LOCOMOTIVE ENGINE. The Autobiography of an old Locomotive Engine. By ROBERT WEATHERBURN, M.I.M.E. With Illustrations and Portraits of GEORGE and ROBERT STEPHENSON. Crown 8vo, cloth .. .. *Net* **2s. 6d.**

LOCOMOTIVE ENGINE DEVELOPMENT. A Popular Treatise on the Gradual Improvements made in Railway Engines between 1803 and 1903. By CLEMENT C. STRETTON, C.E. Sixth Edition, Revised and Enlarged. Crown 8vo, cloth ... *Net* **4s. 6d.**

LOCOMOTIVE ENGINE DRIVING. A Practical Manual for Engineers in Charge of Locomotive Engines. By MICHAEL REYNOLDS, M.S.E. Twelfth Edition. Crown 8vo, cloth, **3s. 6d.**; cloth boards **4s. 6d.**

LOCOMOTIVE ENGINES. A Rudimentary Treatise on. By G. D. DEMPSEY, C.E. With large additions treating of the Modern Locomotive, by D. K. CLARK, M.Inst.C.E. With Illustrations. Crown 8vo, cloth .. .. **3s.**

LOCOMOTIVE (MODEL) ENGINEER Fireman and Engine-boy. Comprising a Historical Notice of the Pioneer Locomotive Engines and their Inventors. By MICHAEL REYNOLDS. Crown 8vo, cloth, **3s. 6d.**; cloth boards .. .. **4s. 6d.**

LOCOMOTIVES, THE APPLICATION OF HIGHLY SUPERHEATED STEAM TO. *See* STEAM

MACHINERY, DETAILS OF. Comprising Instructions for the Execution of various Works in Iron in the Fitting Shop, Foundry, and Boiler Yard. By FRANCIS CAMPIN, C.E. Crown 8vo, cloth **3s.**

MACHINE SHOP TOOLS. A Practical Treatise describing in every detail the Construction, Operation and Manipulation of both Hand and Machine Tools, being a work of Practical Instruction in all Classes of Modern Machine Shop Practice, including Chapters on Filing, Fitting and Scraping Surfaces, on Drills, Reamers, Taps and Dies; the Lathe and its Tools, Planers, Shapers and their Tools; Milling Machines and Cutters, Gear Cutters and Gear Cutting; Drilling Machines and Drill Work, Grinding Machines and their Work; Hardening and Tempering, Gearing, Belting, and Transmission Machinery, Useful Data and Tables. By W. H. VAN DERVOORT, M.E. Illustrated by 673 Engravings. Medium 8vo .. . *Net* **21s.**

MAGNETOS FOR AUTOMOBILISTS: How made and How used. A handybook on their Construction and Management. By S. R. BOTTONE. Crown 8vo, cloth . . . . *Net* **2s.**

MARINE ENGINEERING. An Elementary Manual for Young Marine Engineers and Apprentices. By J. S. BREWER. Crown 8vo, cloth.. . . .. **1s. 6d.**

MARINE ENGINEER'S GUIDE to Board of Trade Examinations for Certificates of Competency. Containing all Latest Questions to Date, with Simple, Clear, and Correct Solutions; 302 Elementary Questions with Illustrated Answers, and Verbal Questions and Answers; complete Set of Drawings with Statements completed. By A. C. WANNAN, C.E., Consulting Engineer, and E. W. I. WANNAN, M.I.M.E., Certificated First Class Marine Engineer. With numerous Engravings. Fourth Edition, Enlarged. 500 pages. Large Crown 8vo, cloth

MARINE ENGINEER'S POCKET-BOOK. Containing latest Board of Trade Rules and Data for Marine Engineers. By A. C. WANNAN. Fourth Edition, Revised, Enlarged, and brought up to Date. Square 18mo, with thumb Index, leather ... ... 5s.

MARINE ENGINES AND BOILERS. Their Design and Construction. A Handbook for the Use of Students, Engineers, and Naval Constructors. Based on the Work "Berechnung und Konstruktion der Schiffsmaschinen und Kessel," by Dr. G. BAUER, Engineer-in-Chief of the Vulcan Shipbuilding Yard, Stettin. Translated from the Second German Edition by E. M. DONKIN and S. BRYAN DONKIN, A.M.I.C.E. Edited by LESLIE S. ROBERTSON, Secretary to the Engineering Standards Committee, M.I.C.E., M.I.M.E., M.I.N.A., Etc. With numerous Illustrations and Tables Medium 8vo, cloth ... . *Net* 25s.

SUMMARY OF CONTENTS. PART I. MAIN ENGINES: DETERMINATION OF CYLINDER DIMENSIONS—THE UTILISATION OF STEAM IN THE ENGINE STROKE OF PISTON—NUMBER OF REVOLUTIONS—TURNING MOMENT—BALANCING OF THE MOVING PARTS—ARRANGEMENT OF MAIN ENGINES DETAILS OF MAIN ENGINES THE CYLINDER—VALVES VARIOUS KINDS OF VALVE GEAR—PISTON RODS—PISTONS CONNECTING ROD AND CROSSHEAD—VALVE GEAR RODS—BED PLATES—ENGINE COLUMNS REVERSING AND TURNING GEAR PART II PUMPS. AIR, CIRCULATING FEED, AND AUXILIARY PUMPS PART III SHAFTING, RESISTANCE OF SHIPS, PROPELLERS: THRUST SHAFT AND THRUST BLOCK—TUNNEL SHAFTS AND PLUMMER BLOCKS SHAFT COUPLINGS STERN TUBE—THE SCREW PROPELLER—CONSTRUCTION OF THE SCREW. PART IV PIPES AND CONNECTIONS: GENERAL REMARKS, FLANGES, VALVES, ETC UNDER-WATER FITTINGS MAIN STEAM, AUXILIARY STEAM, AND EXHAUST PIPING FEED WATER, BILGE, BALLAST AND CIRCULATING PIPES. PART V STEAM BOILERS: FIRING AND THE GENERATION OF STEAM CYLINDRICAL BOILERS—LOCOMOTIVE BOILERS—WATER-TUBE BOILERS—SMALL TUBE WATER TUBE BOILERS—SMOKE BOX—FUNNEL AND BOILER LAGGING—FORCED DRAUGHT—BOILER FITTINGS AND MOUNTINGS. PART VI MEASURING INSTRUMENTS PART VII VARIOUS DETAILS: BOLTS, NUTS, SCREW THREADS, ETC—PLATFORMS GRATINGS LADDERS FOUNDATIONS—SEATINGS—LUBRICATION—VENTILATION OF ENGINE ROOMS—RULES FOR SPARE GEAR PART VIII ADDITIONAL TABLES.

"This handsome volume contains a comprehensive account of the design and construction of modern marine engines and boilers Its arrangement is excellent, and the numerous illustrations represent recent practice for all classes of warships and vessels of the mercantile marine His position as Engineer-in-Chief of the great Vulcan Works at Stettin gave the author special facilities for selecting illustrations from the practice of that firm, which has built many of the swiftest types of steamships for both war and commerce Other German firms and the German Admiralty have been equally generous in contributing information, while a large proportion of the Illustrations is drawn from English technical journals and the proceedings of our engineering societies American practice is also represented. The compilation has been laborious, no doubt, but it constitutes a valuable book of reference and a treasury of information The English editor and his assistants have done their work well, both in translation and in the conversion of metric to English measures *The Times.*

MARINE ENGINES AND STEAM VESSELS. By R. MURRAY, C.E. Eighth Edition, thoroughly Revised, with Additions by the Author and by GEORGE CARLISLE, C.E. Crown 8vo, cloth 4s. 6d.

MASONRY DAMS FROM INCEPTION TO COMPLETION. Including numerous Formulæ, Forms of Specification and Tender, Pocket Diagram of Forces, etc. For the use of Civil and Mining Engineers. By C. F. COURTNEY, M.Inst C.E. 8vo, cloth ... 9s.

MASTING, MAST-MAKING, AND RIGGING OF SHIPS. Also Tables of Spars, Rigging, Blocks; Chain, Wire, and Hemp Ropes, etc., relative to every class of vessels By R. KIPPING. Crown 8vo, cloth .. .. 2s.

MATERIALS AND CONSTRUCTION. A Theoretical and Practical Treatise on the Strains, Designing, and Erection of Works of Construction. By F. CAMPIN Crown 8vo, cloth .. ... 3s.

MATERIALS, A TREATISE ON THE STRENGTH OF. By P. BARLOW, F.R.S., P. W. BARLOW, F.R.S., and W. H. BARLOW, F.R.S. Edited by WM. HUMBER, A.M.Inst.C.E. 8vo, cloth ... 18s.

MATHEMATICAL TABLES. For Trigonometrical, Astronomical, and Nautical Calculations; to which is prefixed a Treatise on Logarithms, by H. LAW, C.E. With Tables for Navigation and Nautical Astronomy. By Prof. J. R. YOUNG. Crown 8vo, cloth . . . 4s.

MEASURES: BRITISH AND AMERICAN CUSTOMARY AND METRIC LEGAL MEASURES. For Commercial and Technical Purposes, forming the Measure Section of Part I. of "The Mechanical Engineer's Reference Book." By NELSON FOLEY, M.I.N.A. Folio, cloth ... ... [*Just ready.* *Net* 7s. 6d.

MEASURES—LEGAL STANDARDS—LINEAL, SQUARE—CUBIC AND CAPACITY—WEIGHT—COMPOUND UNITS—VELOCITY AND SPEED—MEASURES OF GRAVITY—MASS—FORCE—WORK—POWER—ELECTRICAL—HEAT—MOMENTS—ENERGY—MOMENTUM—CENTRIFUGAL FORCE—ANGLES—EQUIVALENTS—CUSTOMARY MEASURES TO METRIC, AND *vice versa*—LINEAL—SQUARE—CUBIC AND CAPACITY—WEIGHT AND MONEY (ENGLISH, AMERICAN AND FRENCH).

MECHANICAL ENGINEERING. Comprising Metallurgy, Moulding, Casting, Forging, Tools, Workshop Machinery, Mechanical Manipulation, Manufacture of the Steam Engine, etc. By FRANCIS CAMPIN, C.E. Third Edition. Crown 8vo, cloth .. ... 2s. 6d.

MECHANICAL ENGINEERING TERMS. LOCKWOOD'S DICTIONARY. Embracing terms current in the Drawing Office, Pattern Shop, Foundry, Fitting, Turning, Smiths', and Boiler Shops, etc. Comprising upwards of 6,000 Definitions. Edited by J. G. HORNER, A.M.I.M.E. Third Edition, Revised, with Additions. Crown 8vo, cloth. *Net* 7s. 6d.

MECHANICAL ENGINEER'S COMPANION. Areas, Circumferences, Decimal Equivalents, in inches and feet, millimetres, squares, cubes, roots, etc., Strength of Bolts, Weight of Iron, etc.; Weights, Measures, and other Data. Also Practical Rules for Engine Proportions. By R. EDWARDS, M.Inst.C.E. Fcap. 8vo, cloth 3s. 6d.

MECHANICAL ENGINEER'S POCKET-BOOK. Comprising Tables, Formulæ, Rules, and Data. A Handy Book of Reference for Daily use in Engineering Practice. By D. KINNEAR CLARK, M.Inst.C.E., Sixth Edition, thoroughly Revised and Enlarged. By H. H. P. POWLES, A.M.Inst.C.E., M.I.M.E. Small 8vo, 700 pp., Leather. *Net* 6s.

MATHEMATICAL TABLES—MEASUREMENT OF SURFACES AND SOLIDS—ENGLISH WEIGHTS AND MEASURES—FRENCH METRIC WEIGHTS AND MEASURES—FOREIGN WEIGHTS AND MEASURES—MONEYS—SPECIFIC GRAVITY, WEIGHT, AND VOLUME—MANUFACTURED METALS—STEEL PIPES—BOLTS AND NUTS—SUNDRY ARTICLES IN WROUGHT AND CAST IRON, COPPER, BRASS, LEAD, TIN, ZINC—STRENGTH OF MATERIALS—STRENGTH OF TIMBER—STRENGTH OF CAST IRON—STRENGTH OF WROUGHT IRON—STRENGTH OF STEEL—TENSILE STRENGTH OF COPPER, LEAD, ETC.—RESISTANCE OF STONES AND OTHER BUILDING MATERIALS—RIVETED JOINTS IN BOILER PLATES—BOILER SHELLS—WIRE ROPES AND HEMP ROPES—CHAINS AND CHAIN CABLES—FRAMING—HARDNESS OF METALS, ALLOYS AND STONES—LABOUR OF ANIMALS—MECHANICAL PRINCIPLES—GRAVITY AND FALL OF BODIES—ACCELERATING AND RETARDING FORCES—MILL GEARING, SHAFTING, ETC.—TRANSMISSION OF MOTIVE POWER—HEAT—COMBUSTION: FUELS—WARMING, VENTILATION, COOKING STOVES—STEAM—STEAM ENGINES AND BOILERS—RAILWAYS—TRAMWAYS—STEAM SHIPS—PUMPING STEAM ENGINES AND PUMPS—COAL GAS—GAS ENGINES, ETC.—AIR IN MOTION—COMPRESSED AIR—HOT AIR ENGINES—WATER POWER—SPEED OF CUTTING TOOLS—COLOURS—ELECTRICAL ENGINEERING.

MECHANICAL ENGINEER'S REFERENCE BOOK. Fo Machine and Boiler Construction. By NELSON FOLEY, M.I.N.A. New Edition, Revised. [*In Preparation*

The Measure Section of Part I.—**BRITISH AND AMERICAN CUSTOMARY AND METRIC LEGAL MEASURES**—now ready. *Se* under MEASURES

MECHANICAL HANDLING OF MATERIAL. A Treatise on the Handling of Material such as Coal, Ore, Timber, etc., by Automatic or Semi-Automatic Machinery, together with the Various Accessories used in the Manipulation of such Plant, and Dealing fully with the Handling, Storing, and Warehousing of Grain. By G. F. ZIMMER, A.M.Inst.C.E. 528 pp. Royal 8vo, cloth, with 550 Illustrations (including Folding Plates) specially prepared for the Work ... *Net* 25s.

MECHANICS. Being a concise Exposition of the General Principles of Mechanical Science and their Applications. By C. TOMLINSON, F.R.S. Crown 8vo, cloth ... ... 1s. 6d.

MECHANICS CONDENSED. A Selection of Formulæ, Rules, Tables, and Data for the Use of Engineering Students, etc. By W. G. C. HUGHES, A.M.I.C.E. Crown 8vo, cloth ... ... 2s. 6d.

MECHANICS OF AIR MACHINERY. By Dr. J. WIESBACH and Prof. G. HERRMANN. Authorised Translation with an Appendix on American Practice by A. TROWBRIDGE, Ph.B., Adjunct Professor of Mechanical Engineering, Columbia University. Royal 8vo, cloth. *Net* 18s.

MECHANICS' WORKSHOP COMPANION. Comprising a great variety of the most Useful Rules and Formulæ in Mechanical Science, with numerous Tables of Practical Data and Calculated Results for Facilitating Mechanical Operations. By WILLIAM TEMPLETON, Author of "The Engineer's Practical Assistant," etc., etc. Eighteenth Edition, Revised, Modernised, and considerably Enlarged by W. S. HUTTON, C.E., Author of "The Works' Manager's Handbook," etc. F'cp. 8vo, nearly 500 pp., with 8 Plates and upwards of 250 Diagrams, leather ... ... 6s.

MECHANISM AND MACHINE TOOLS. By T. BAKER, C.E. With Remarks on Tools and Machinery by J. NASMYTH, C.E. Crown 8vo, cloth ... ... 2s. 6d.

MENSURATION AND MEASURING. With the Mensuration and Levelling of Land for the Purposes of Modern Engineering. By T. BAKER, C.E. New Edition by E. NUGENT, C.E. Crown 8vo, cloth ... ... 1s. 6d.

METAL-TURNING. A Practical Handbook for Engineers, Technical Students, and Amateurs. By JOSEPH HORNER, A.M.I.Mech.E., Author of "Pattern Making," etc. Large Crown 8vo, cloth, with 488 Illustrations ... ... *Net* 9s.

SUMMARY OF CONTENTS:—INTRODUCTION. RELATIONS OF TURNERY AND MACHINE SHOP—SEC. I. THE LATHE, ITS WORK AND TOOLS—FORMS AND FUNCTIONS OF TOOLS—REMARKS ON TURNING IN GENERAL—SEC. II. TURNING BETWEEN CENTRES—CENTRING AND DRIVING—USE OF STEADIES—EXAMPLES OF TURNING INVOLVING LINING-OUT THE CENTRES—MANDREL WORK—SEC. III. WORK SUPPORTED AT ONE END—FACE PLATE TURNING—ANGLE PLATE TURNING—INDEPENDENT JAW CHUCKS—CONCENTRIC, UNIVERSAL, TOGGLE, AND ALLIED CHUCKS—SEC. IV. INTERNAL WORK—DRILLING, BORING AND ALLIED OPERATIONS—SEC. V. SCREW CUTTING AND TURRET WORK—SEC. VI. MISCELLANEOUS—SPECIAL WORK—MEASUREMENT, GRINDING—TOOL HOLDERS—SPEED AND FEEDS—TOOL STEELS—STEEL MAKERS' INSTRUCTIONS.

METRIC TABLES. In which the British Standard Measures and Weights are compared with those of the Metric System at present in Use on the Continent. By C. H. DOWLING, C.E. 8vo, cloth 10s. 6d.

MILLING MACHINES: their Design, Construction, and Working. A Handbook for Practical Men and Engineering Students. By JOSEPH HORNER, A.M.I.Mech.E., Author of "Pattern Making," etc. With 269 Illustrations. Medium 8vo, cloth ... *Net* [illegible] 6d.

Leading Elements of Milling Machine Design and Construction—Plain and Universal Machines—Attachments and Bracings—Vertical Spindle Machines—Plano-Millers or Slabbing Machines—Special Machines—Cutters—Milling Operations—Indexing, Spiral Work, and Worm, Spur, and Bevel Gears, etc.—Spur and Bevel Gears—Feeds and Speeds.

MOTOR CAR CATECHISM. Containing about 320 Questions and Answers Explaining the Construction and Working of a Modern Motor Car. For the Use of Owners, Drivers, and Students. By JOHN HENRY KNIGHT. Second Edition, Revised and Enlarged, with an Additional chapter on Motor Cycles. Crown 8vo, with Illustrations.

[*Just published.* *Net* 1s. 6d.

The Petrol Engine—Transmission and the Chassis—Tyres—Duties of a Car Driver—Motor Cycles—Laws and Regulations.

MOTOR CAR ENGINEERING. Practical Lectures on the Motor Car. By ROBERT W. A. BREWER, A.M.Inst.C.E., M.I.M.E., M.I.A.E. With numerous illustrations. Demy 8vo, cloth.

[*Just published.* *Net* 5s.

History of the Internal Combustion Engine—Two-Cycle Engines—Large Engines—Scavenging—Mechanical Details of Construction—Details of the Moving Parts—Stratification—Thermal Efficiency—Calculation of Extent of Heat Losses—Testing of Gas Engines and Calculation of Results—Gas Producers—Oil Engines—The Petrol Engine as Employed in the Motor Car—Power and Weight of Petrol Engines—Friction and Lubrication of Engines—Clutches and Change Speed Gear—Transmission Gear—Live Axles and Chain Drive—Brakes—The Differential Gear—Frames—Suspension—Steering—Radiation—Ignition Mechanism—Carburation—Liquid Fuel—Benzol—Fuel Mixtures—Alcohol—Carburetters and the Flow of Fuel—Modernising a Motor Car—The Care of the Car.

MOTOR CARS FOR COMMON ROADS. By A. J. WALLIS-TAYLER, A.M.Inst.C.E. 212 pp., with 76 Illustrations. Crown 8vo, cloth . . . . . 4s. 6d.

MOTOR VEHICLES FOR BUSINESS PURPOSES. A Practical Handbook for those interested in the Transport of Passengers and Goods. By A. J. WALLIS-TAYLER, A.M.Inst.C.E. With 134 Illustrations. Demy 8vo, cloth . . . ... *Net* 9s.

NAVAL ARCHITECT'S AND SHIPBUILDER'S POCKET-BOOK. Of Formulæ, Rules, and Tables, and Marine Engineer's and Surveyor's Handy Book of Reference. By CLEMENT MACKROW, M.I.N.A. Ninth Edition. F'cap., leather *Net* 12s. 6d.

Signs and Symbols, Decimal Fractions—Trigonometry—Practical Geometry—Mensuration—Centres and Moments of Figures—Moments of Inertia and Radii of Gyration—Algebraical Expressions for Simpson's Rules—Mechanical Principles—Centre of Gravity—Laws of Motion—Displacement, Centre of Buoyancy—Centre of Gravity of Ship's Hull—Stability Curves and Metacentres—Sea and Shallow-water Waves—Rolling of Ships—Propulsion and Resistance of Vessels—Speed Trials—Sailing, Centre of Effort—Distances down Rivers, Coast Lines—Steering and Rudders of Vessels—Launching Calculations and Velocities—Weight of Material and Gear—Gun Particulars and Weight—Standard Gauges—Riveted Joints and Riveting—Strength and Tests of Materials—Binding and Shearing Stresses—Strength of Shafting, Pillars, Wheels, etc.—Hydraulic Data, etc.—Conic Sections, Catenarian Curves—Mechanical Powers, Work—Board of Trade Regulations for Boilers and Engines—Board of Trade Regulations for Ships—Lloyd's Rules for Boilers—Lloyd's Weight of Chains—Lloyd's Scantlings for Ships—Data of Engines and Vessels—Ships' Fittings and Tests—Seasoning Preserving Timber—Measurement of Timber—Alloys, Paints, Varnishes—Data for Stowage—Admiralty Transport Regulations—Rules for Horse-power, Screw Propellers, etc.—Percentages for Butt Straps—Particulars of Yachts—Masting and Rigging—Distances of Foreign Ports—Tonnage Tables—Vocabulary of French and English Terms—English Weights and Measures—Foreign Weights and Measures—Decimal Equivalents—Useful Numbers—Circular Measures—Areas of and Circumferences of Circles—Areas of Segments of Circles—Tables of Squares and Cubes and Roots of Numbers—Tables of Logarithms of Numbers—Tables of Hyperbolic Logarithms—Tables of Natural Sines, Tangents—Tables of Logarithmic Sines, Tangents, etc.

NAVAL ARCHITECTURE. An Exposition of the Elementary Principles. By J. PEAKE. Crown 8vo, cloth ... ... **3s. 6d.**

NAVIGATION AND NAUTICAL ASTRONOMY. In Theory and Practice. By Prof. J. R. YOUNG. Crown 8vo, cloth **2s. 6d.**

"A very complete, thorough, and useful manual for the young navigator."—*Observatory.*

NAVIGATION, PRACTICAL. Consisting of the Sailor's Sea Book, by J. GREENWOOD and W. H. ROSSER; together with Mathematical and Nautical Tables for the Working of the Problems, by H. LAW, C.E., and Prof. J. R. YOUNG ... ... **7s.**

PATTERN MAKING. Embracing the Main Types of Engineering Construction, and including Gearing, Engine Work, Sheaves and Pulleys, Pipes and Columns, Screws, Machine Parts, Pumps and Cocks, the Moulding of Patterns in Loam and Greensand, Weight of Castings, etc. By J. G. HORNER, A.M.I.M.E. Third Edition, Enlarged. With 486 Illustrations. Crown 8vo, cloth ... *Net* **7s. 6d.**

"A well-written technical guide, evidently written by a man who understands and has practised what he has written about."—*Builder.*

PATTERN MAKING. A Practical Work on the Art of Making Patterns for Engineering and Foundry Work, including (among other matter) Materials and Tools, Wood Patterns, Metal Patterns, Pattern Shop Mathematics, Cost, Care, etc., of Patterns. By F. W. BARROWS. Fully Illustrated by Engravings made from Special Drawings by the Author. Crown 8vo, cloth ... ... *Net* **6s.**

PATTERN MAKERS AND PATTERN MAKING—MATERIALS AND TOOLS—EXAMPLES OF PATTERN WORK—METAL PATTERNS—PATTERN SHOP MATHEMATICS—COST, CARE, AND INVENTORY OF PATTERNS—MARKING AND RECORD OF PATTERNS—PATTERN ACCOUNTS.

PETROL AIR GAS. A Practical Handbook on the Installation and Working of Air Gas Lighting Systems for Country Houses. By HENRY O'CONNOR, F.R.S.E., A.M.Inst.C.E., &c., author of "The Gas Engineer's Pocket Book." 80 pages with Illustrations. Crown 8vo, cloth [*Just published.* *Net* **1s. 6d.**

DESCRIPTION OF PREVIOUS PLANTS AND SYSTEMS FOR COUNTRY-HOUSE LIGHTING, DIFFICULTIES WITH, OBJECTIONS AND PRICES—HISTORY OF PETROL GAS, COMPARATIVE COSTS—PETROL, ITS NATURE, DANGERS AND STORING, NOTES ON THE LAW REGARDING SAME—BURNERS, DESCRIPTION OF SAME, PIPING, MANTLES—GENERAL PRINCIPLES OF PARTS OF PLANTS—MOTIVE POWER METERS—WEIGHT-DRIVEN PLANTS—ROOT'S BLOWERS—HOT-AIR ENGINES—PELTON WATER-WHEELS—DESCRIPTION OF VARIOUS PLANTS—EXTRACT FROM AN ACT FOR THE SAFE-KEEPING OF PETROLEUM AND OTHER SUBSTANCES OF A LIKE NATURE—APPENDIX—USEFUL NOTES.

PIONEER ENGINEERING. A Treatise on the Engineering Operations connected with the Settlement of Waste Lands in New Countries. By E. DOBSON, M.Inst.C.E. Second Edition. Crown 8vo, cloth ... ... **4s. 6d.**

PNEUMATICS. Including Acoustics and the Phenomena of Wind Currents, for the Use of Beginners. By CHARLES TOMLINSON, F.R.S. Crown 8vo, cloth ... ... **1s. 6d.**

PUMPS AND PUMPING. A Handbook for Pump Users. Being Notes on Selection, Construction, and Management. By M. POWIS BALE, M.Inst.C.E., M.I.Mech.E. Fifth Edition. Crown 8vo, cloth, **3s. 6d.**

"The matter is set forth as concisely as possible. In fact, condensation rather than diffuseness has been the author's aim throughout; yet he does not seem to have omitted anything likely to be of use."—*Journal of Gas Lighting.*

PUNCHES, DIES, AND TOOLS FOR MANUFACTURING IN PRESSES. By JOSEPH V. WOODWORTH. Medium 8vo, cloth, 482 pages with 700 Illustrations . . .. *Net* 16s.

SIMPLE BENDING AND FORMING DIES, THEIR CONSTRUCTION, USE AND OPERATION—INTRICATE COMBINATION, BENDING, AND FORMING DIES, FOR ACCURATE AND RAPID PRODUCTION—AUTOMATIC FORMING, BENDING, AND TWISTING DIES AND PUNCHES, FOR DIFFICULT AND NOVEL SHAPING. CUT, CARRY AND FOLLOW DIES, TOGETHER WITH TOOL COMBINATIONS FOR PROGRESSIVE SHEET METAL WORKING. NOTCHING, PERFORATING AND PIERCING PUNCHES, DIES AND TOOLS—COMPOSITE, SECTIONAL, COMPOUND AND ARMATURE DISK AND SEGMENT PUNCHES AND DIES—PROCESSES AND TOOLS FOR MAKING RIFLE CARTRIDGES, CARTRIDGE CASES OF QUICK-FIRING GUNS, AND NICKEL BULLET JACKETS. THE MANUFACTURE AND USE OF DIES FOR DRAWING WIRE AND BAR STEEL. PENS, PINS AND NEEDLES, THEIR EVOLUTION AND MANUFACTURE—PUNCHES, DIES, AND PROCESSES FOR MAKING HYDRAULIC PACKING LEATHERS, TOGETHER WITH TOOLS FOR PAINT AND CHEMICAL TABLETS. DRAWING, RE-DRAWING, REDUCING, FLANGING, FORMING, REVERSING, AND CUPPING PROCESSES. PUNCHES AND DIES FOR CIRCULAR AND RECTANGULAR AND SHEET-METAL ARTICLES. BEADING, WIRING, CURLING, AND SEAMING PUNCHES AND DIES FOR CLOSING AND ASSEMBLING OF METAL PARTS. JEWELLERY DIE MAKING, EYEGLASS LENS AND MEDAL DIES AND CONSTRUCTION OF SHOE AND FORK MAKING TOOLS. DESIGN, CONSTRUCTION AND USE OF SUB-PRESSES AND SUB-PRESS DIES. DIES FOR WATCH AND CLOCK WORK AND ACCURATE PIERCING AND PUNCHING. DROP FORGING AND DIE-SINKING, TOGETHER WITH MAKING OF DROP DIES, STEAM HAMMER DIES. NUMBERING PUNCH TOOLS AND DIES FOR BOLT MACHINES—METHODS, DESIGNS, WAYS, KINKS, FIXTURES AND TOOLS FOR SPECIAL WORK TOGETHER WITH MISCELLANEOUS INFORMATION FOR DIE MAKERS AND SHEET METAL GOODS MANUFACTURERS—SPECIAL AND NOVEL PROCESSES, PRESSES AND FEEDS FOR WORKING SHEET METAL IN DIES.

RECLAMATION OF LAND FROM TIDAL WATERS. A Handbook for Engineers, Landed Proprietors, and others interested in Works of Reclamation. By A. BEAZELEY, M.Inst.C.E. 8vo, cloth *Net* 10s. 6d.

"The work contains a great deal of practical and useful information which cannot fail to be of service to engineers entrusted with the enclosure of salt marshes, and to landowners intending to reclaim land from the sea."—*The Engineer.*

REFRIGERATING AND ICE-MAKING MACHINERY. A Descriptive Treatise for the Use of Persons Employing Refrigerating and Ice-making Installations, and others. By A. J. WALLIS-TAYLER, A.M.Inst.C.E. Third Edition, Enlarged. Crown 8vo, cloth 7s. 6d.

"May be recommended as a useful description of the machinery, the processes, and of the facts, figures, and tabulated physics of refrigerating."—*Engineer.*

REFRIGERATION AND ICE-MAKING POCKET-BOOK. By A. J. WALLIS-TAYLER, A.M.Inst.C.E., Author of "Refrigerating and Ice-making Machinery," etc. Fourth Edition. Crown 8vo, cloth *Net* 3s. 6d.

REFRIGERATION, COLD STORAGE, AND ICE-MAKING. A Practical Treatise on the Art and Science of Refrigeration. By A. J. WALLIS-TAYLER, A.M.Inst.C.E., Author of "Refrigerating and Ice-Making Machinery." 600 pp., with 360 Illustrations. Medium 8vo, cloth ... ... *Net* 15s.

"The author has to be congratulated on the completion and production of such an important work, and it cannot fail to have a large body of readers, for it leaves out nothing that would in any way be of value to those interested in the subject."—*Steamship.*

RIVER BARS. The Causes of their Formation, and their Treatment by "Induced Tidal Scour"; with a Description of the Successful Reduction by this Method of the Bar at Dublin. By I. J. MANN, Assist. Eng. to the Dublin Port and Docks Board. Royal 8vo, cloth 7s. 6d.

"We recommend all interested in harbour works—and, indeed, those concerned in the improvements of rivers generally—to read Mr. Mann's interesting work."—*Engineer.*

ROADS AND STREETS. By H. Law, C.E., and D. K. Clark, C.E. Revised, with Additional Chapters by A. J. Wallis-Tayler, A.M.Inst.C.E. Seventh Edition. Crown 8vo, cloth ... ... **6s.**

"A book which every borough surveyor and engineer must possess, and which will be of considerable service to architects, builders, and property owners generally."—*Building News.*

ROOFS OF WOOD AND IRON. Deduced chiefly from the Works of Robison, Tredgold, and Humber. By E. W. Tarn, M.A., Architect. Fifth Edition. Crown 8vo, cloth ... ... **1s. 6d.**

SAFE RAILWAY WORKING. A Treatise on Railway Accidents, their Cause and Prevention; with a Description of Modern Appliances and Systems. By Clement E. Stretton, C.E. Third Edition, Enlarged. Crown 8vo, cloth ... ... **3s. 6d.**

SAFE USE OF STEAM. Containing Rules for Unprofessional Steam Users. By an Engineer. Eighth Edition. Sewed ... **6d.**

"If steam-users would but learn this little book by heart, boiler explosions would become sensations by their rarity."—*English Mechanic.*

SAILMAKING. By Samuel B. Sadler, Practical Sailmaker, late in the employment of Messrs. Ratsey and Lapthorne, of Cowes and Gosport. Second Edition, Revised and Enlarged. Plates. 4to, cloth *Net* **12s. 6d.**

SAILOR'S SEA BOOK. A Rudimentary Treatise on Navigation. By James Greenwood, B.A. With numerous Woodcuts and Coloured Plates. New and Enlarged Edition. By W. H. Rosser. Crown 8vo, cloth ... ... **2s. 6d.**

SAILS AND SAILMAKING. With Draughting, and the Centre of Effort of the Sails. Weights and Sizes of Ropes; Masting, Rigging and Sails of Steam Vessels, etc. By R. Kipping, N.A. Crown 8vo, cloth **2s. 6d.**

SCREW-THREADS, and Methods of Producing Them. With numerous Tables and complete Directions for using Screw Cutting Lathes. By Paul N. Hasluck, Author of "Lathe-Work," etc. Sixth Edition. Waistcoat-pocket size .. .. **1s. 6d.**

"Full of useful information, hints, and practical criticism. Taps, dies, and screwing tools generally are illustrated and their action described."—*Mechanical World.*

SEA TERMS, PHRASES, AND WORDS (Technical Dictionary. French-English, English-French), used in the English and French Languages. For the Use of Seamen, Engineers, Pilots, Shipbuilders, Shipowners, and Shipbrokers. Compiled by W. Pirrie, late of the African Steamship Company. F'cap. 8vo, cloth ... **5s.**

SHIPBUILDING INDUSTRY OF GERMANY. Compiled and Edited by G. Lehmann-Felskowski. With Coloured Prints, Art Supplements, and numerous Illustrations throughout the text. Super-royal 4to, cloth ... ... *Net* **10s. 6d.**

SHIPS AND BOATS. By W. Bland. With numerous Illustrations and Models. Tenth Edition. Crown 8vo, cloth ... **1s. 6d.**

SHIPS FOR OCEAN AND RIVER SERVICE. Principles of the Construction of. By H. A. Sommerfeldt. Crown 8vo. **1s. 6d.**

ATLAS OF ENGRAVINGS. To illustrate the above. Twelve large folding Plates. Royal 4to, cloth ... . **7s. 6d.**

SMITHY AND FORGE. Including the Farrier's Art and Coach Smithing. By W. J. E. Crane. Crown 8vo, cloth ... ... **2s. 6d.**

STATICS, GRAPHIC AND ANALYTIC. In their Practical Application to the Treatment of Stresses in Roofs, Solid Girders, Lattice, Bowstring, and Suspension Bridges, Braced Iron Arches and Piers, and other Frameworks. By R. HUDSON GRAHAM, C.E. Containing Diagrams and Plates to Scale. With numerous Examples, many taken from existing structures. Specially arranged for Class-work in Colleges and Universities. Second Edition, Revised and Enlarged. 8vo, cloth. **16s.**

"Mr. Graham's book will find a place wherever graphic and analytic statics are used or studied." —*Engineer*

STATIONARY ENGINE DRIVING. A Practical Manual for Engineers in Charge of Stationary Engines. By MICHAEL REYNOLDS, M.S.E. Eighth Edition. Crown 8vo, cloth, **3s. 6d.**; cloth boards ... ... **4s. 6d.**

"The author is thoroughly acquainted with his subjects and has produced a manual which is an exceedingly useful one for the class for whom it is specially intended."—*Engineering*.

STATIONARY ENGINES. A Practical Handbook of their Care and Management for Men-in-Charge. By C. HURST. Crown 8vo *Net* **1s.**

STEAM: THE APPLICATION OF HIGHLY SUPERHEATED STEAM TO LOCOMOTIVES. Being a reprint from a Series of Articles appearing in "The Engineer." By ROBERT GARBE, Privy Councillor, Prussian State Railways. Translated from the German. Edited by LESLIE S. ROBERTSON, Secretary of the Engineering Standards Committee, M.Inst.C.E., M.I.Mech.E., M.Inst.N.A., etc. Medium 8vo, cloth ... ... [*Just published.* **7s. 6d.**

STEAM AND THE STEAM ENGINE, Stationary and Portable. Being an Extension of the Treatise on the Steam Engine of Mr. J. SEWELL. By D. K. CLARK, C.E. Fourth Edition. Crown 8vo, cloth ... ... **3s. 6d.**

"Every essential part of the subject is treated of competently, and in a popular style."—*Iron*.

STEAM AND MACHINERY MANAGEMENT. A Guide to the Arrangement and Economical Management of Machinery, with Hints on Construction and Selection. By M. POWIS BALE, M.Inst.M.E. Crown 8vo, cloth ... ... **2s. 6d.**

"Gives the results of wide experience."—*Lloyd's Newspaper*.

STEAM ENGINE. A Practical Handbook compiled with especial Reference to Small and Medium-sized Engines. For the Use of Engine Makers, Mechanical Draughtsmen, Engineering Students, and users of Steam Power. By HERMAN HAEDER, C.E. Translated from the German, with additions and alterations, by H. H. P. POWLES, A.M.I.C.E., M.I.M.E. Third Edition, Revised. With nearly 1,100 Illustrations. Crown 8vo, cloth ... ... *Net* **7s. 6d.**

"This is an excellent book, and should be in the hands of all who are interested in the construction and design of medium-sized stationary engines . . . A careful study of its contents and the arrangement of the sections leads to the conclusion that there is probably no other book like it in this country. The volume aims at showing the results of practical experience, and it certainly may claim a complete achievement of this idea."—*Nature*.

STEAM ENGINE. A Treatise on the Mathematical Theory of, with Rules and Examples for Practical Men. By T. BAKER, C.E. Crown 8vo, cloth ... ... **1s. 6d.**

STEAM ENGINE. For the Use of Beginners. By Dr. LARDNER. Crown 8vo, cloth ... ... **1s. 6d.**

STEAM ENGINE. A Text-Book on the Steam Engine, with a Supplement on Gas Engines and Part II. on Heat Engines. By T. M. GOODEVE, M.A., Barrister-at-Law, Professor of Mechanics at the Royal College of Science, London; Author of "The Principles of Mechanics," "The Elements of Mechanism," etc. Fourteenth Edition. Crown 8vo, cloth ... ... **6s.**

STEAM ENGINE (PORTABLE). A Practical Manual on its Construction and Management. For the Use of Owners and Users of Steam Engines generally. By WILLIAM DYSON WANSBROUGH. Crown 8vo, cloth ... . **3s. 6d.**

"This is a work of value to those who use steam machinery. . . . Should be read by everyone who has a steam engine, on a farm or elsewhere."—*Mark Lane Express.*

STEAM ENGINEERING IN THEORY AND PRACTICE. By GARDNER D. HISCOX, M.E. With Chapters on Electrical Engineering. By NEWTON HARRISON, E.E., Author of "Electric Wiring, Diagrams, and Switchboards." 450 pages. Over 400 Detailed Engravings *Net* **12s. 6d.**

HISTORICAL—STEAM AND ITS PROPERTIES—APPLIANCES FOR THE GENERATION OF STEAM—TYPES OF BOILERS—CHIMNEY AND ITS WORK—HEAT ECONOMY OF THE FEED WATER—STEAM PUMPS AND THEIR WORK INCRUSTATION AND ITS WORK—STEAM ABOVE ATMOSPHERIC PRESSURE—FLOW OF STEAM FROM NOZZLES—SUPERHEATED STEAM AND ITS WORK—ADIABATIC EXPANSION OF STEAM—INDICATOR AND ITS WORK—STEAM ENGINE PROPORTIONS—SLIDE VALVE ENGINES AND VALVE MOTION—CORLISS ENGINE AND ITS VALVE GEAR—COMPOUND ENGINE AND ITS THEORY—TRIPLE AND MULTIPLE EXPANSION ENGINE—STEAM TURBINE—REFRIGERATION—ELEVATORS AND THEIR MANAGEMENT—COST OF POWER—STEAM ENGINE TROUBLES—ELECTRIC POWER AND ELECTRIC PLANTS

STONE BLASTING AND QUARRYING. For Building and other Purposes. With Remarks on the Blowing up of Bridges. By Gen. Sir J. BURGOYNE, K.C.B. Crown 8vo, cloth ... ... **1s. 6d.**

STONE-WORKING MACHINERY. A Manual dealing with the Rapid and Economical Conversion of Stone. With Hints on the Arrangement and Management of Stone Works. By M. POWIS BALE, M.Inst.C.E. Crown 8vo, cloth ... ... **9s.**

"Should be in the hands of every mason or student of stonework."—*Colliery Guardian.*

STRAINS, HANDY BOOK FOR THE CALCULATION OF. In Girders and Similar Structures and their Strength. Consisting of Formulæ and Corresponding Diagrams, with numerous details for Practical Application, etc. By WILLIAM HUMBER, A M.Inst.C.E., etc. Sixth Edition. Crown 8vo, with nearly 100 Woodcuts and 3 Plates, cloth ... ... **7s. 6d.**

"We heartily commend this really *handy* book to our engineer and architect readers."—*English Mechanic*

STRAINS ON STRUCTURES OF IRONWORK. With Practical Remarks on Iron Construction. By F. W. SHEILDS, M.Inst.C E. 8vo, cloth ... . **5s.**

SUBMARINE TELEGRAPHS. Their History, Construction, and Working. Founded in part on Wunschendorff's "Traité de Télégraphie Sous-Marine," and compiled from Authoritative and Exclusive Sources. By CHARLES BRIGHT, F.R.S.E., A.M.Inst.C.E., M.I.Mech.E., M.I.E.E. Super royal 8vo, nearly 800 pages, fully Illustrated, including a large number of Maps and Folding Plates, strongly bound in cloth. *Net* **£3 3s.**

"Mr. Bright's interestingly written and admirably illustrated book will meet with a welcome reception from cable men."—*Electrician.*

SUPERHEATED STEAM, THE APPLICATION OF, TO LOCOMOTIVES. *See* Steam.

SURVEYING AS PRACTISED BY CIVIL ENGINEERS AND SURVEYORS. Including the Setting-out of Works for Construction and Surveys Abroad, with many Examples taken from Actual Practice. A Handbook for Use in the Field and the Office, intended also as a Text-book for Students. By John Whitelaw, Jun., A.M.Inst.C.E., Author of "Points and Crossings." With about 260 Illustrations. Second Edition. Demy 8vo, cloth ... ... *Net* **10s. 6d.**

Surveying with the Chain only—Surveying with the Aid of Angular Instruments—Levelling—Adjustment of Instruments—Railway (including Road) Survey and Setting Out—Tacheometry or Stadia Surveying—Tunnel Alignment and Setting Out—Surveys for Water Supply Works—Hydrographical or Marine Surveying—Astronomical Observations used in Surveying—Explanation of Astronomical Terms—Surveys Abroad in Jungle, Dense Forest, and Unmapped Open Country—Trigonometrical or Geodetic Surveys.

"This work is written with admirable lucidity, and will certainly be found of distinct value both to students and to those engaged in actual practice."—*The Builder.*

SURVEYING, LAND AND ENGINEERING. For Students and Practical Use. By T. Baker, C.E. Twentieth Edition, by E. E. Dixon, A.M.Inst.C.E. With Plates and Diagrams. Crown 8vo, cloth **2s.**

SURVEYING, LAND AND MARINE. In Reference to the Preparation of Plans for Roads and Railways; Canals, Rivers, Towns' Water Supplies; Docks and Harbours. With Description and Use of Surveying Instruments. By W. Davis Haskoll, C.E. Second Edition, Revised, with Additions. Large Crown 8vo, cloth ... ... **9s.**

"This book must prove of great value to the student. We have no hesitation in recommending it, feeling assured that it will more than repay a careful study."—*Mechanical World.*

SURVEYING, PRACTICAL. A Text-book for Students Preparing for Examinations or for Survey Work in the Colonies. By George W. Usill, A.M.Inst.C.E. Eighth Edition, thoroughly Revised and Enlarged by Alex. Beazeley, M.Inst.C.E. With 4 Lithographic Plates and 360 Illustrations. Large crown 8vo, **7s. 6d.** cloth; or, on thin paper, leather, gilt edges, rounded corners, for pocket use, **12s. 6d.**

Ordinary Surveying—Surveying Instruments—Trigonometry required in Surveying—Chain-Surveying—Theodolite Surveying—Traversing—Town-Surveying—Levelling—Contouring—Setting out Curves—Office Work—Land Quantities—Colonial Licensing Regulations—Hypsometer Tables—Introduction to Tables of Natural Sines, etc.—Natural Sines and Co-Sines—Natural Tangents and Co-Tangents—Natural Secants and Co-Secants.

"The first book which should be put in the hands of a pupil of civil engineering."—*Architect.*

SURVEYING, TRIGONOMETRICAL. An Outline of the Method of Conducting a Trigonometrical Survey. For the Formation of Geographical and Topographical Maps and Plans, Military Reconnaissance, Levelling, etc., with Useful Problems, Formulæ and Tables. By Lieut.-General Frome, R.E. Fourth Edition, Revised and partly Re-written by Major-General Sir Charles Warren, G.C.M.G., R.E. With 19 Plates and 115 Woodcuts. Royal 8vo, cloth ... ... **16s.**

SURVEYING WITH THE TACHEOMETER. A Practical Manual for the Use of Civil and Military Engineers and Surveyors, including two series of Tables specially computed for the Reduction of Readings in Sexagesimal and in Centesimal Degrees. By Neil Kennedy, M.Inst.C.E. With Diagrams and Plates. Second Edition. Demy 8vo, cloth ... ... *Net* **10s. 6d.**

"The work is very clearly written, and should remove all difficulties in the way of any surveyor desirous of making use of this useful and rapid instrument."—*Nature.*

SURVEY PRACTICE. For Reference in Surveying, Levelling, and Setting-out; and in Route Surveys of Travellers by Land and Sea. With Tables, Illustrations, and Records. By L. D'A. JACKSON, A.M.Inst.C.E. Third Edition. 8vo, cloth ... ... **12s. 6d.**

SURVEYOR'S FIELD BOOK FOR ENGINEERS AND MINING SURVEYORS. Consisting of a Series of Tables, with Rules, Explanations of Systems, and Use of Theodolite for Traverse Surveying and Plotting the work with minute accuracy by means of Straight Edge and Set Square only; Levelling with the Theodolite, Setting-out Curves with and without the Theodolite, Earthwork Tables, etc. By W. DAVIS HASKOLL, C.E. With numerous Woodcuts. Fifth Edition, Enlarged. Crown 8vo, cloth ... ... **12s.**

TECHNICAL TERMS, English-French, French-English: A Pocket Glossary; with Tables suitable for the Architectural, Engineering, Manufacturing, and Nautical Professions. By JOHN JAMES FLETCHER. Fourth Edition, 200 pp. Waistcoat-pocket size, limp leather . . **1s. 6d.**

TECHNICAL TERMS, Eng.-Spanish, Spanish-Eng.: A Pocket Glossary suitable for the Engineering, Manufacturing, and Mining Industries. By R. D. MONTEVERDE, B.A. (Madrid). 316 pp. Waistcoat-pocket size, limp leather. [*Just published.* *Net.* **2s. 6d.**

TELEPHONES: THEIR CONSTRUCTION, INSTALLATION, WIRING, OPERATION AND MAINTENANCE. A Practical Reference Book and Guide for Electricians, Wiremen, Engineers, Contractors, Architects, and others interested in Standard Telephone Practice. By W. H. RADCLIFFE and H. C. CUSHING, JR. 180 pages. With 125 Illustrations. Fcap. 8vo, cloth.
[*Just published.* *Net* **4s. 6d.**

TELEPHONES: FIELD TELEPHONES FOR ARMY USE: INCLUDING AN ELEMENTARY COURSE IN ELECTRICITY AND MAGNETISM. By Lieut. E. J. STEVENS, D.O., R.A., A.M.I.E.E., Instructor in Electricity, Ordnance College, Woolwich. Crown 8vo, cloth. With Illustrations. [*Just published.* *Net* **2s.**

BATTERIES—ELECTRICAL CIRCUITS—MAGNETISM—INDUCTION—MICROPHONES AND RECEIVERS—PORTABLE AND FIELD TELEPHONE SETS—SELF-INDUCTION, INDUCTIVE CAPACITY, ETC.

TELEPHONY. *See* WIRELESS TELEPHONY and WIRELESS TELEGRAPHY.

TOOLS FOR ENGINEERS AND WOODWORKERS. Including Modern Instruments of Measurement. By JOSEPH HORNER, A.M.Inst.M.E., Author of "Pattern Making," etc. Demy 8vo, with 456 Illustrations ... ... *Net* **9s.**

SUMMARY OF CONTENTS:—INTRODUCTION—GENERAL SURVEY OF TOOLS—TOOL ANGLES—SEC. I. CHISEL GROUP—CHISELS AND APPLIED FORMS FOR WOODWORKERS—PLANES—HAND CHISELS AND APPLIED FORMS FOR METAL WORKING—CHISEL-LIKE TOOLS FOR METAL TURNING, PLANING, ETC.—SHEARING ACTION AND SHEARING TOOLS—SEC. II. EXAMPLES OF SCRAPING TOOLS—SEC. III. TOOLS—RELATING TO CHISELS AND SCRAPERS—SAWS—FILES—MILLING CUTTERS—BORING TOOLS FOR WOOD AND METAL—TAPS AND DIES—SEC. IV. PERCUSSIVE AND MOULDING TOOLS—PUNCHES, HAMMERS AND CAULKING TOOLS—MOULDING AND MODELLING TOOLS—MISCELLANEOUS TOOLS—SEC. V. HARDENING, TEMPERING, GRINDING AND SHARPENING—SEC. VI. TOOLS FOR MEASUREMENT AND TEST—STANDARDS OF MEASUREMENT—SQUARES, SURFACE PLATES, LEVELS, BEVELS, PROTRACTORS, ETC.—SURFACE GAUGES OR SCRIBING BLOCKS—COMPASSES AND DIVIDERS—CALIPERS, VERNIER CALIPERS, AND RELATED FORMS—MICROMETER CALIPERS—DEPTH GAUGES AND ROD GAUGES—SNAP CYLINDRICAL AND LIMIT GAUGES—SCREW THREAD, WIRE AND REFERENCE GAUGES—INDICATORS, ETC.

TOOTHED GEARING. A Practical Handbook for Offices and Workshops. By J. HORNER, A.M.I.M.E. Second Edition, with a New Chapter on Recent Practice. With 184 Illustrations. Crown 8vo, cloth. **6s.**

TRAMWAYS: THEIR CONSTRUCTION AND WORKING. Embracing a Comprehensive History of the System; with an exhaustive Analysis of the Various Modes of Traction, including Horse Power, Steam, Cable Traction, Electric Traction, &c.; a Description of the Varieties of Rolling Stock; and ample Details of Cost and Working Expenses. New Edition, thoroughly revised, and Including the Progress recently made in Tramway Construction, etc. By D. KINNEAR CLARK, M.Inst.C.E. With 400 Illustrations. 8vo, 780 pp. buckram ... **28s.**

TRUSSES OF WOOD AND IRON. Practical Applications of Science in Determining the Stresses, Breaking Weights, Safe Loads, Scantlings, and Details of Construction. With Complete Working Drawings. By W. GRIFFITHS, Surveyor. Oblong 8vo, cloth **4s. 6d.**

"This handy little book enters so minutely into every detail connected with the construction of roof trusses that no student need be ignorant of these matters."—*Practical Engineer*

TUNNELLING. A Practical Tréatise. By CHARLES PRELINI, C.E. With additions by CHARLES S. HILL, C.E. With 150 Diagrams and Illustrations. Royal 8vo, cloth ... ... *Net* **16s.**

TUNNELLING, PRACTICAL. Explaining in detail Setting-out the Works, Shaft sinking, and Heading-driving, Ranging the Lines and Levelling underground, Sub-Excavating, Timbering and the Construction of the Brickwork of Tunnels. By F. W. SIMMS, M.Inst.C.E. Fourth Edition, Revised and Further Extended, including the most recent (1895) Examples of Sub-aqueous and other Tunnels, by D. KINNEAR CLARK, M.Inst.C.E. With 34 Folding Plates. Imperial 8vo, cloth ... **£2 2s.**

TUNNEL SHAFTS. A Practical and Theoretical Essay on the Construction of large Tunnel Shafts. By J. H. WATSON BUCK, M.Inst.C.E., Resident Engineer, L. and N. W. R. With Folding Plates, 8vo, cloth ... ... **12s.**

"Will be regarded by civil engineeers as of the utmost value, and calculated to save much time and obviate many mistakes."—*Colliery Guardian*

WAGES TABLES. At 54, 52, 50 and 48 Hours per Week. Showing the Amounts of Wages from One quarter of an hour to Sixty-four hours, in each case at Rates of Wages advancing by One Shilling from 4*s.* to 55*s.* per week. By THOS. GARBUTT, Accountant. Square Crown 8vo, half-bound ... ... **6s.**

WATER ENGINEERING. A Practical Treatise on the Measurement, Storage, Conveyance, and Utilisation of Water for the Supply of Towns, for Mill Power, and for other Purposes. By CHARLES SLAGG, A.M.Inst.C.E. Second Edition. Crown 8vo, cloth ... ... **7s. 6d.**

WATER, POWER OF. As Applied to Drive Flour Mills and to give Motion to Turbines and other Hydrostatic Engines. By JOSEPH GLYNN, F.R.S., etc. New Edition. Illustrated. Crown 8vo, cloth **2s.**

VATER SUPPLY OF CITIES AND TOWNS. B WILLIAM HUMBER, A.M.Inst.C.E. and M.Inst.M.E., Author of "Ca and Wrought Iron Bridge Construction," etc., etc. Illustrated with 5 Double Plates, 1 Single Plate, Coloured Frontispiece, and upwards c 250 Woodcuts, and containing 400 pp. of Text. Imperial 4to, elegantl and substantially half-bound in morocco ... ... *Net £6 6*

LIST OF CONTENTS:—I. Historical Sketch of some of the Means that hav een adopted for the Supply of Water to Cities and Towns—II. Water and th oreign Matter usually Associated with it.—III. Rainfall and Evaporation.—I prings and the Water-bearing Formations of Various Districts.—V. Measuremen nd Estimation of the Flow of Water.—VI. On the Selection of the Source o upply.—VII. Wells.—VIII. Reservoirs.—IX. The Purification of Water.—X. Pumps.— I. Pumping Machinery.—XII. Conduits.—XIII. Distribution of Water.—XIV. Meter ervice Pipes, and House Fittings.—XV. The Law and Economy of Water Works.— VI. Constant and Intermittent Supply.—XVII. Description of Plates—Appendice iving Tables of Rates of Supply, Velocities, etc., etc., together with Specificatio f Several Works Illustrated, among which will be found: Aberdeen, Bidefor anterbury, Dundee, Halifax, Lambeth, Rotherham, Dublin, and others.

"The most systematic and valuable work upon water supply hitherto produced in English, or ny other language. Mr. Humber's work is characterised almost throughout by an exhaustivene uch more distinctive of French and German than of English technical treatises."—*Engineer.*

VATER SUPPLY OF TOWNS AND THE CON STRUCTION OF WATERWORKS. A Practical Treatise for th Use of Engineers and Students of Engineering. By W. K. BURTO A.M.Inst.C.E., Consulting Engineer to the Tokyo Waterworks. Thir Edition, Revised. Edited by ALLAN GREENWELL, F.G.S., A.M.Inst.C.E., with numerous Plates and Illustrations. Super-royal 8vo, buckram. **25s.**

I. Introductory.—II. Different Qualities of Water.—III. Quantity of Water to be rovided.—IV. On Ascertaining whether a Proposed Source of Supply is Sufficient.—V. n Estimating the Storage Capacity Required to be Provided.—VI. Classification of Vaterworks.—VII. Impounding Reservoirs.—VIII. Earthwork Dams.—IX. Masonry ams.—X. The Purification of Water.—XI. Settling Reservoirs.—XII. Sand Filtration.—XIII. Purification of Water by Action of Iron, Softening of Water by Action of ime, Natural Filtration.—XIV. Service or Clean Water Reservoirs—Water Towers— tand Pipes.—XV. The Connection of Settling Reservoirs, Filter Beds and Service eservoirs.—XVI. Pumping Machinery.—XVII. Flow of Water in Conduits—Pipes and pen Channels.—XVIII. Distribution Systems.—XIX. Special Provisions for the Extinction of Fires.—XX. Pipes for Waterworks.—XXI. Prevention of Waste of Water.— XII. Various Appliances used in Connection with Waterworks.

Appendix I. By Prof. John Milne, F.R.S.—Considerations Concerning the Probable ffects of Earthquakes on Waterworks and the Special Precautions to be taken in arthquake Countries.

Appendix II. By John De Rijke, C.E.—On Sand Dunes and Dune Sands as a Source of Vater Supply.

"We congratulate the author upon the practical commonsense shown in the preparation of this ork. . . . The plates and diagrams have evidently been prepared with great care, and cannot ail to be of great assistance to the student."—*Builder.*

WATER SUPPLY, RURAL. A Practical Handbook on the Supply of Water and Construction of Water Works for small Country Districts. By ALLAN GREENWELL, A.M.Inst.C.E., and W. T. CURRY, A.M.Inst.C.E., F.G.S. With Illustrations. Second Edition, Revised. Crown 8vo, cloth ... ... **5s.**

"The volume contains valuable information upon all matters connected with water supply. . . . It is full of details on points which are continually before water-works engineers."—*Nature.*

WELLS AND WELL-SINKING. By J. G. SWINDELL, A.R.I.B.A., and G. R. BURNELL, C.E. Revised Edition. Crown 8vo, cloth **2s.**

WIRELESS TELEGRAPHY: ITS THEORY AND PRACTICE. A Handbook for the use of Electrical Engineers, Students and Operators. By JAMES ERSKINE-MURRAY, D.Sc., Fellow of the Royal Society of Edinburgh, Member of the Institution of Electrical Engineers. Second Edition, Revised and Enlarged 370 pages, with over 150 Diagrams and Illustrations. Demy 8vo, cloth . . . . [*Just Published.* *Net* **10s. 6d.**

Adaptations of the Electric Current to Telegraphy—Earlier Attempts at Wireless Telegraphy—Apparatus used in the Production of High Frequency Currents—Detection of Short-Lived Currents of High Frequency by means of Imperfect Electrical Contacts—Detection of Oscillatory Currents of High Frequency by their Effects on Magnetised Iron—Thermometric Detectors of Oscillatory Currents of High Frequency—Electrolytic Detectors—The Marconi System—The Lodge-Muirhead System—The Fessenden System—The Hozier-Brown System—Wireless Telegraphy in Alaska—The De Forest System—The Poulsen System—The Telefunken System—Directed Systems—Some Points in the Theory of Jigs and Jiggers—On Theories of Transmission—World-Wave Telegraphy—Adjustments, Electrical Measurements and Fault Testing—On the Calculation of a Syntonic Wireless Telegraph Station—Tables and Notes.

". . . . A serious and meritorious contribution to the literature on this subject. The Author brings to bear not only great practical knowledge, gained by experience in the operation of wireless telegraph stations, but also a very sound knowledge of the principles and phenomena of physical science. His work is thoroughly scientific in its treatment, shows much originality throughout, and merits the close attention of all students of the subject."—*Engineering.*

WIRELESS TELEPHONY IN THEORY AND PRACTICE. By ERNST RUHMER. Translated from the German by J. ERSKINE-MURRAY, D.Sc., M.I.E.E., etc. Author of "A Handbook of Wireless Telegraphy." With numerous Illustrations. Demy 8vo, cloth .. .. *Net* **10s. 6d.**

"A very full descriptive account of the experimental work which has been carried out on Wireless Telephony is to be found in Professor Ruhmer's book . . . The volume is profusely illustrated by both photographs and drawings, and should prove a useful reference Work for those directly or indirectly interested in the subject."—*Nature*

"The explanations and discussions are all clear and simple, and the whole volume is a very readable record of important and interesting work."—*Engineering.*

"The translator is to be congratulated upon the selection of his task, and upon the excellent manner in which he has accomplished it: for this is a book that marks an era in the progress of applied science."—*Times.*

"The book is well written and contains much interesting information on a subject which promises great developments."—*Glasgow Herald.*

WORKSHOP PRACTICE. As applied to Marine, Land, and Locomotive Engines, Floating Docks, Dredging Machines, Bridges, Shipbuilding, etc. By J. G. WINTON. Fourth Edition, Illustrated. Crown 8vo, cloth ... ... **3s. 6d.**

WORKS' MANAGER'S HANDBOOK. Comprising Modern Rules, Tables, and Data. For Engineers, Millwrights, and Boiler Makers; Toolmakers, Machinists, and Metal Workers; Iron and Brass Founders, etc. By W. S. HUTTON, Civil and Mechanical Engineer, Author of "The Practical Engineer's Handbook," Seventh Edition, carefully Revised and Enlarged. Medium 8vo, strongly bound **15s.**

Stationary and Locomotive Steam-Engines, Gas Producers, Gas-Engines, Oil-Engines, etc.—Hydraulic Memoranda: Pipes, Pumps, Water-Power, etc.—Millwork: Shafting, Gearing, Pulleys, etc.—Steam Boilers, Safety Valves, Factory Chimneys, etc.—Heat, Warming, and Ventilation—Melting, Cutting, and Finishing Metals—Alloys and Casting—Wheel-Cutting, Screw-Cutting, etc.—Strength and Weight of Materials—Workshop Data, etc.

"The volume is an exceedingly useful one, brimful with engineer's notes, memoranda and rules, and well worthy of being on every mechanical engineer's bookshelf."—*Mechanical World.*

PUBLICATIONS OF THE ENGINEERING STANDARDS COMMITTEE.

MESSRS. CROSBY LOCKWOOD and SON, having been appointed OFFICIAL PUBLISHERS to the ENGINEERING STANDARDS COMMITTEE, beg to invite attention to the List given below of the Publications already issued by the Committee, and will be prepared to supply copies thereof and of all subsequent Publications as issued.

The ENGINEERING STANDARDS COMMITTEE is the outcome of a Committee appointed by the Institution of Civil Engineers at the instance of Sir John Wolfe Barry, K.C.B., to inquire into the advisability of Standardising Rolled Iron and Steel Sections.

The Committee as now constituted is supported by the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, and the Institution of Electrical Engineers; and the value and importance of its labours—not only to the Engineering profession, but to the country at large—has been emphatically recognised by His Majesty's Government, who have made a liberal grant from the Public Funds by way of contribution to the financial resources of the Committee, and have placed at its disposal the services (on the several Sub-Committees) of public officials of the highest standing selected from various Government Departments.

The subjects already dealt with, or under consideration by the Committee, include not only Rolled Iron and Steel Sections, but Tests for Iron and Steel Material used in the Construction of Ships and their Machinery, Bridges and General Building Construction, Railway Rolling Stock Underframes, Component Parts of Locomotives, Railway and Tramway Rails, Electrical Plant, Insulating Materials, Screw Threads and Limit Gauges, Pipe Flanges, Cement, etc.

These particulars will be sufficient to show the importance to the Trade and Industries of the Empire of the work the Committee has undertaken.

Reports already published :—

1. **BRITISH STANDARD SECTIONS** (9 lists).—ANGLES, EQUAL AND UNEQUAL—BULB ANGLES, TEES AND PLATES—Z AND T BARS—CHANNELS BEAMS ... ... **1s.** *Net.*
2. **TRAMWAY RAILS AND FISH-PLATES** ... ... **21s.** *Net.*
3. **REPORT ON THE INFLUENCE OF GAUGE LENGTH.** By Professor W. C. UNWIN, F.R.S. ... ... **2s 6d.** *Net.*
4. **PROPERTIES OF STANDARD BEAMS.** (*Included in No.* 6.) **1s.** *Net.*
5. **STANDARD LOCOMOTIVES FOR INDIAN RAILWAYS.** **10s. 6d.** *Net.*
6. **PROPERTIES OF BRITISH STANDARD SECTIONS.** Diagrams, Definitions, Tables, and Formulæ ... ... **5s.** *Net.*
7. **TABLES OF COPPER CONDUCTORS AND THICKNESSES OF DIELECTRIC** ... ... **2s. 6d.** *Net.*

PUBLICATIONS OF THE ENGINEERING STANDARDS COMMITTEE

8. TUBULAR TRAMWAY POLES ... ... [illegible]
9. BULL-HEADED RAILWAY RAILS ... ... 10s. 6d. Net
10. TABLES OF PIPE FLANGES ... ... [illegible]
11. FLAT-BOTTOMED RAILWAY RAILS ... ... 10s. [illegible]
12. SPECIFICATION FOR PORTLAND CEMENT 2s. 6d. Net
13. STRUCTURAL STEEL FOR SHIPBUILDING... 2s. 6d. Net
14. STRUCTURAL STEEL FOR MARINE BOILERS 2s. 6d. Net
15. STRUCTURAL STEEL FOR BRIDGES AND GENERAL BUILDING CONSTRUCTION ... ... 2s. 6d. Net
16. SPECIFICATIONS AND TABLES FOR TELEGRAPH MATERIAL ... ... 10s. 6d. Net
17. INTERIM REPORT ON ELECTRICAL MACHINERY 2s. 6d. Net
19. REPORT ON TEMPERATURE EXPERIMENTS ON FIELD COILS OF ELECTRICAL MACHINES ... ... 5s. Net
20. BRITISH STANDARD SCREW THREADS ... 2s. 6d. Net
21. BRITISH STANDARD PIPE THREADS ... 2s. 6d. Net
22. THE EFFECT OF TEMPERATURE ON INSULATING MATERIALS ... ... 5s. Net
23. STANDARDS FOR TROLLEY GROOVE AND WIRE 1s. Net
24. MATERIAL USED IN THE CONSTRUCTION OF RAILWAY ROLLING STOCK ... ... 10s. 6d. Net
25. ERRORS IN WORKMANSHIP. Based on Measurements carried out by the National Physical Laboratory ... ... 10s. 6d. Net
26. SECOND REPORT ON LOCOMOTIVES FOR INDIAN RAILWAYS ... ... 10s. 6d. Net
27. STANDARD SYSTEMS FOR LIMIT GAUGES. (Running Fits.) 2s. 6d. Net
28. NUTS, BOLT-HEADS, AND SPANNERS ... 2s. 6d. Net
29. INGOT STEEL FORGINGS FOR MARINE PURPOSES. 2s. 6d. Net
30. INGOT STEEL CASTINGS FOR MARINE PURPOSES. 2s. 6d. Net
31. STEEL CONDUITS FOR ELECTRICAL WIRING 2s. 6d. Net
32. STEEL BARS (for use in Automatic Machines) ... ... 2s. 6d. Net
33. CARBON FILAMENT GLOW LAMPS ... ... 5s. Net
34. WHITWORTH, FINE, AND PIPE THREADS. (Mounted on can and varnished.) ... ... 6d. Net
35. COPPER ALLOY BARS (for use in Automatic Machines) 2s. 6d. Net
36. STANDARDS FOR ELECTRICAL MACHINERY. 2nd Report. 1s. Net
37. CONSUMERS ELECTRIC SUPPLY METERS (Motor Type fo Continuous and Single-Phase Circuits) ... ... 2s. 6d. Net
38. LIMIT GAUGES FOR SCREW THREADS ... ... 1s. Net
39. COMBINED REPORTS ON SCREW THREADS (containing Nos 20, 28, 38) ... ... 3s. 6d. Net
40. CAST IRON SPIGOT AND SOCKET LOW PRESSURE HEATING PIPES ... ... 2s. 6d. Net
41. CAST IRON SPIGOT AND SOCKET FLUE OR SMOK PIPES ... ... 2s. 6d. Net

---

London: Crosby Lockwood & Son,
7, STATIONERS' HALL COURT, LUDGATE HILL, E.C.
and 121a, Victoria Street, Westminster, S.W.